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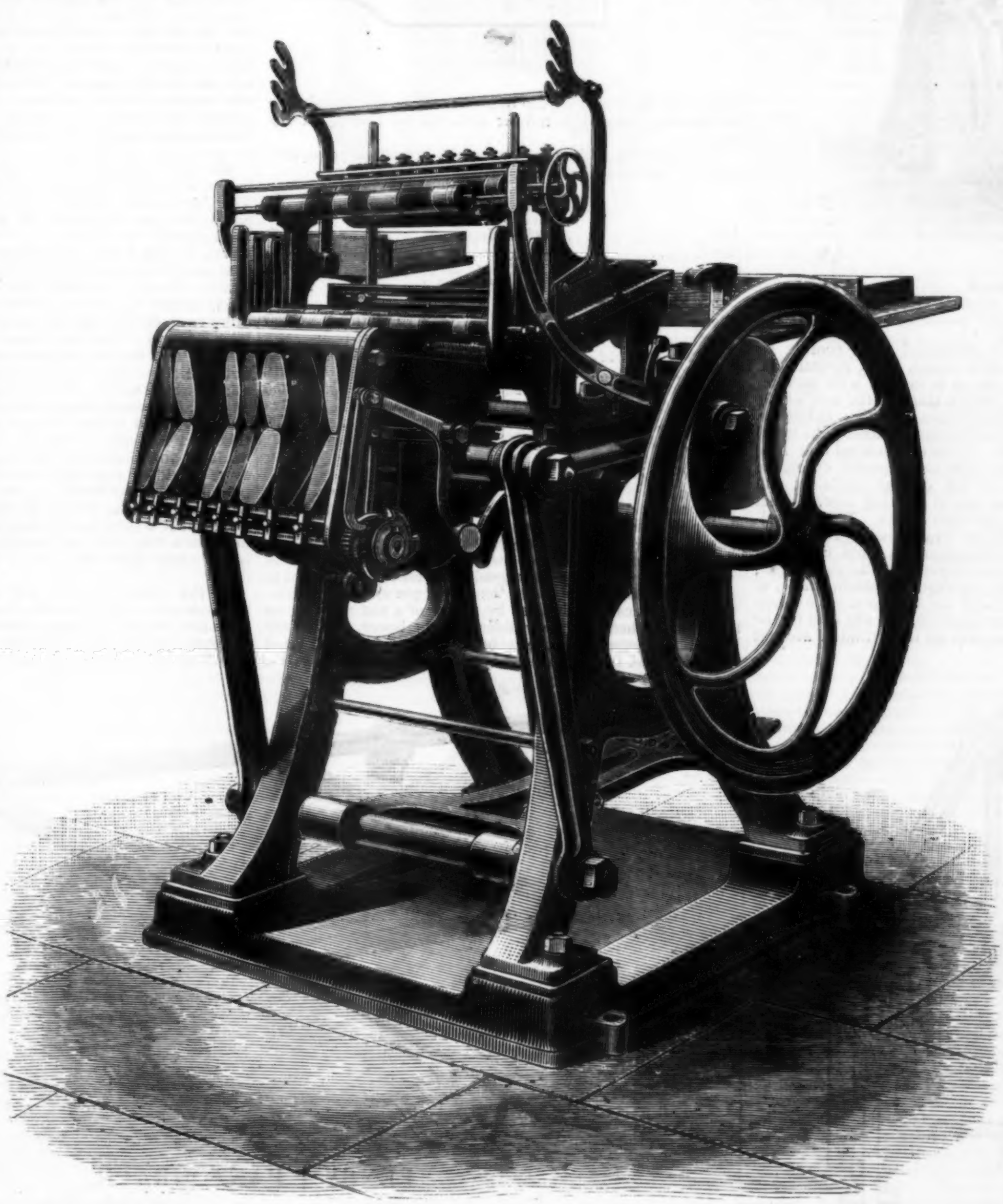
WORKING CLASSES IN SOUTHERN ITALY.

AN English newspaper correspondent, who has been visiting the manufacturing districts of Southern Italy, writes that he had never before seen or dreamed of such misery and oppression as the working classes there endure. He says: From Salerno I drove through a fertile valley where the oats and barley are nearly ripe; the wheat droops with its own weight; the grapes are full budded. Olive-clad hills, oak and chestnut studded groves, stretch to the horizon on either side. But the striking feature of the landscape is the manufactory—gaunt, immense, glaring, sending up its clouds of smoke to the blue and cloudless sky. I presented my card and obtained permission to enter. The first thing that strikes one is the enormous number of women, girls, and little children, carrying and unloading baskets of coal far too heavy for any of them. If you ask how much they earn, you are told, "A farthing an hour the children; somewhat less than a halfpenny the women and girls." "How many hours do they work?" "From dawn to dusk," is the invariable reply. In the entire establishment about 2,500 people are employed, chiefly women and children, because their work costs less. The men earn 10d. a day in summer, 7d. and 8d. in winter; the women, 5d. to 8d.; the children, 2d. to 5d. As they live at distances from two to six miles from the manufactory, none go home during the dinner hour. Once there was a soup kitchen, but soup making occupied time and labor, so a *pagnotto* of brown bread is substituted and distributed at midday to the working population, the price of the brown loaf being subtracted from the daily earnings. The eating of this brown bread is the only break in the twelve or fourteen hours' working day. I have visited many English factories where the atmosphere is sufficiently vitiated, but five minutes in these cotton mills beat me altogether. In one upper room were four hundred looms, one woman keeping two in work, a passage between the sets barely allowing two persons to pass abreast; every window hermetically closed. The haggard, pallid faces of the women; the wan, wizened, wistful faces of the children, need another pen than mine to describe. "Why, in God's name, don't you open the windows?" I asked, as one of my Italian companions turned sick and faint, and the walls seemed to reel around me. "Oh," said the overseer, "the hotter it is and the more the breaths are condensed the quicker go the machines, and the less break in the cotton threads." One scarcely dares imagine what those rooms would be when the gas is alight, or during the heat of an Italian summer; yet day and night—for the workmen and women come in two relays—these poor creatures work literally for their daily bread. And for what bread? Your paupers would fling it at the heads of the guardians, and with such loaves your prison inmates would stone their jailers. As you wind upward from the lower valleys, past newly planted parks and recently built villas, where the extraordinary fertility of the soil contrasts strangely with the emaciated forms and general wretchedness of the laborers, you come upon hamlets and villages, or, as they say here, communes; everywhere you find a lottery bank installed, everywhere receiving officers of the *dazio e consumo*—that is to say, of the tax on the common necessities of life; everywhere a municipal palace, a church, and a prison. Having expressed a wish to a friend who accompanied me to see one of the Italian kept woolen manufactories, I was given my choice of four, and alighted at the nearest. Here the condition of the working classes is at its lowest; they work as long as daylight lasts, there being no night relays; the men receive 9d., the women 4d., 5d., and 6d.—that is to say, they ought to receive this sum, but they are compelled, one and all, to take the bread furnished by the contractor, otherwise twenty per cent. is deducted when the wages are paid fortnightly. In comparison with this bread, that furnished at the large manufactory is as gold to copper—this is made of the refuse of macaroni, such as is elsewhere given to swine and poultry. There are, besides, fines for every imaginable sin of omission or commission—fines for being late, fines for smoking, talking, or laughing; fines for supposed or real imperfections in the "pieces." Perhaps fines may be necessary for discipline and for keeping order, and we know that they exist in Tuscany, especially at the Ginori porcelain factory at the Doccia; but there at least they revert to the workingmen themselves, are handed over to the fund for the sick, infirm, and orphans. But here the head of the factory divides the spoil with his agent, so it may be imagined how keen is the latter on the least shortcoming. Of infant schools there are none in the district, no hospital, no almshouse. The other day an old man who, I am told, was faint with hunger and blind with fatigue, had his arm torn off by one of the leathern straps. "He must have been drunk," quoth the owner, and the man was left to die of gangrene. One of the sights that revolt is that of young girls bearing heavy weights on their heads.

MANY-COLOR PRINTING PRESS.

WE present herewith a figure of a new press, which, with a single form and at a single impression, prints in several colors. This result is obtained by a special arrangement of the inking table, a full view of which is seen in the figure. This table, instead of being in a single piece, is composed of a certain number of narrow cast-iron plates held in a frame. These plates are formed of four distinct parts, and are wide in the center and taper conically toward the extremity. This mode of construction allows them to move easily on each side at every revolution of the table, and has nearly the effect of an articulated joint. The end piece near the ink-trough is stationary. The various colored inks are placed in the ink-trough, which is divided into cells by metallic partitions. Directly over the trough is an iron frame carrying a set of screws and nuts. By tightening these screws, which are placed over the metallic partitions, the inks as they flow beneath are prevented from mixing. The inking rollers, instead of being fixed at a certain angle relative to the table, are arranged so as to run perfectly straight, the distribution being effected by the plates above described. The different inks are spread on the multiple table in the usual way. As a consequence of the motion of the articulated joint, the inking table is caused to move slightly in one direction and the other at every revolution of the table, and the ink is thus as well distributed as if several rollers were used. The movable plates which constitute the inking table are of different widths, so that the uppermost or the lowest line in a prospectus can be printed in a color selected beforehand. Motion is communicated to the movable plates by a small lever which hangs under the table, and which rests on a small vertical iron plate affixed to a cross-stay of the machine. The removal of an ordinary inking table and its substitution by the multicolorous one can be effected while the form is being prepared. There is, however, no reason why the articulated table should not be used for work in black; it is only necessary to have a sufficient number of plates to cover the whole breadth, and then the rollers may be allowed to run obliquely as usual. With this apparatus a demi-octavo prospectus may be readily printed in eight colors at a single impression, each color being brilliant and perfectly distinct from the others. As the rollers move in a perfectly straight line the inks do not mix, although the plates which carry them may be placed as close together as necessary.



IMPROVEMENT IN MULTICOLOR PRINTING PRESSES.

This same system of multicolorous tables may be applied to various printing presses. The impression can be made in just as many colors as may be desired, and with such advantages it is certain that the use of such a method must become widespread for printing prospectuses, circulars, bills of fare, and other work of this nature. The apparatus will effect a complete revolution in colored work, since the difference in price between printing in black and printing in colors by the Bacon system is very slight, being merely the difference between the cost of black and colored inks. We should remark, in conclusion, that two colors cannot be printed on the same line—neither in initials nor in borders—since the colors are arranged in a straight line; but it will be readily understood that, by superposing the colors and taking several successive impressions, the most varied effects may be obtained.

KINGDON'S PATENT COMPOUND ENGINE.

WE annex engravings of a small steam launch engine, designed and patented by Mr. George Kingdon, of Kingswear, England, the perspective view showing the general arrangement of the engine, while the section through the two cylinders and valve chest will explain its special features. The principal points in it are, a single valve governing the admission of steam to both cylinders, and a grooved piston rod which obviates the necessity for a high pressure gland, thereby effecting a considerable saving of space as compared with the ordinary type of tandem engine. Both cylinders are arranged to carry the steam through about nine-tenths of the stroke, and their areas are made proportional to the number of expansions required.

As will be seen, there is no receiver, the steam passing through the slide valve from the high to the low pressure

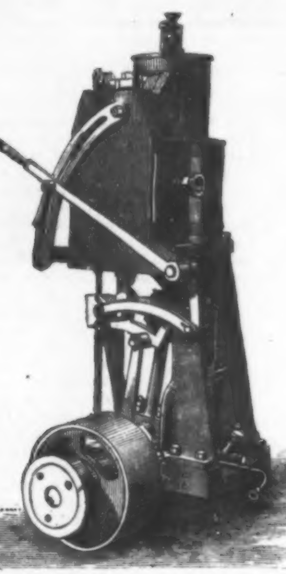


FIG. 1.

cylinder, and while doing so is prevented from cooling by the steam at boiler pressure with which it is surrounded. The rod of the high pressure piston is formed with annular grooves and projecting rings, which rings fit the wall of the aperture in the partition plate between the two cylinders, and form a steam-tight joint at that part, whereby the usual stuffing box is dispensed with. It will be noticed that it is only during the up-stroke that there is a material difference of pressure on the two sides of the central partition, and during that stroke the piston rod is moving toward that cylinder in which the higher pressure exists. This materially increases the efficiency of the arrangement. During the down-stroke leakage around the piston rod from the upper to the lower cylinder is of no importance. The engine can, of course, be made either with equilibrium piston valve, or with the ordinary slide valve, and the arrangement is applicable to all forms of compound engines. In the case of the small engine shown by our engravings the cylinders are not

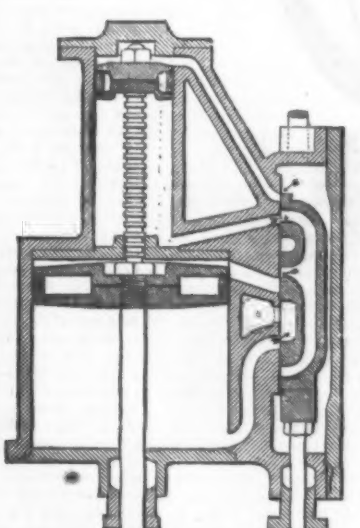


FIG 2.

steam jacketed, but engines of any size would of course be made so.

An engine of this construction has, we are informed, been running for some months, and has given complete satisfaction as to work given out for the steam used, and also as regards saving of trouble and durability of working parts. In this engine twenty-three indicated horse power has been given out from a high pressure cylinder of 5 in. diameter and 7 in. stroke. Some indicator diagrams from one of these engines which we have had the opportunity of examining show an excellent action of the valve and remarkably small drop between the two cylinders. The arrangement altogether forms a very simple and compact type of compound engine which will no doubt find many applications.—*Engineering.*

SHEARING STRENGTHS OF SOME AMERICAN WOODS.

By JOHN C. TRAUTWINE, C.E.

NOTWITHSTANDING the common use of wood for pins or tree nails, no experiments that I know of, except one or two isolated ones, and they imperfect, have been tried for determining the extent of its reliability for this purpose. With a view to supplying this deficiency in some measure, I have recently tested several of our American woods, in the shape of cylindrical pins 0·64 in., or full ⅝ in., in diameter. I used one of Messrs. Riehlé's well known and accurate testing machines, in connection with an iron holder, shown in the figure, and through a cylindrical hole in which the closely fitting wooden pin, *p p*, to be tested, was placed. The two parts, A and B, of this holder being then pulled in opposite directions, it is plain that the pin can yield only by direct shearing at O and C.

Two specimens of each were tried. Where their difference did not exceed 10 per cent., the mean is given. Greater differences must, of course, be of frequent occurrence, even in good sound specimens. All the specimens were fairly seasoned, and without defects. The central pieces sheared off were ⅝ in. long; the single circular area of each pin was 0·322 of a square inch; and that of the two areas that were sheared at once 0·644 of a square inch; and since 0·644 × 1·55 = 1 square inch, it follows that if the results in the

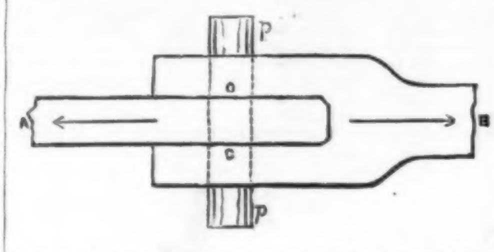


table be divided by 1·55, the quotient will be the actual double shearing strength found for each pin of full ⅝ in. diameter.

The following table gives the results in pounds per square inch of total sheared area:

	Pounds per square inch.		Pounds per square inch.
Ash	6280	Maple	6355
Beech	5223	Oak, white	4425
Birch	5595	" live	8480
Cedar, white. 1372 to	1519	Pine, white	2480
" Central America,	3410	" yellow, northern	4340
Cherry	2945	" " southern	5735
Chestnut	1535	" " very resinous	5053
Dogwood	6510		
Ebony	7750	Poplar	4418
Gum	5890	Spruce	3255
Hemlock	2750	Walnut, black	4728
Hickory 6045 to	7285	" common	2830
Locust	7176		

SIMPLE PANTOGRAPH.

WE annex an illustration of a cheap form of pantograph, designed and manufactured by Mr. J. Beverley Fenby, of Birmingham, and which deserves notice on account of its compact form and excellent workmanship. It is made of strips of varnished pine, the graduated bars being slotted to receive the sliding blocks for the center pin and the pencils. These blocks can be clamped by means of a nut working on a screw attached to a plate sliding on the lower side of the bar. The center pin is attached to a small block of wood secured to the table by means of two sharp-pointed screws.

FENBY'S PANTOGRAPH.

Instead of the caster wheels which are employed on the more expensive arrangements, this pantograph is supported on four studs, the lower ends of which are rounded to enable them to slide freely over the paper. As the instrument is capable of describing a circle of four feet radius, it will be seen that drawings of considerable size can be reduced by it.—*Engineering.*

IT has long been known that fixed ammunition, after years of storage, loses a considerable portion of its energy. M. Porthier, in a paper read before the French Academy of Sciences, endeavors to account for this loss, and he ascribes it to the chemical decomposition of the powder in contact with the metallic case. This deterioration of the powder depends greatly on the condition of the atmosphere, especially its hygrometric state, both at the time the cartridges are manufactured, and during their subsequent storage. Zinc displayed the most activity in deteriorating gunpowder in the presence of moisture, and copper ranked next to zinc.

FLEUSS'S DIVING APPARATUS.*

By B. W. RICHARDSON, M.D., F.R.S.

THOSE of you who would like to study the history of diving, and the attempts that have been made by men of science at various times to live under water, and to live in factitious gases, will study the following books with profit: Lord Bacon's "Novum Organum," "The Philosophical Transactions," from the time of Halley, about 1678, onwards; "The History of Inventions," by Beckmann; Smith's excellent "Panorama of Science," 1824; the Hon. Robert Boyle's "Experimental Philosophy;" Chambers's Encyclopedia"—the large encyclopedia which was the text book of the last century; "The Encyclopedia Britannica;" Siebe and Gorman's book on "Diving;" and an essay by Mr. J. W. Heinke in vol. xv. of the "Proceedings of the Institute of Civil Engineers." In these will be found subject matter worth studying; and they, in fact, as far as I can make out, give a fair history of the origin of those discoveries which have led up to the present day. I must give you, on this occasion, the briefest possible description of the course of discovery, dealing not with diving bells, so much as with the fact of a man being able to live under water by himself, not in combination with others, nor in a bell, but in an apparatus connected with his own body.

We go back to the year 1538, to get the first glimpse of an attempt at the process. Schott, in the "Technica Curiosa," published in Nuremberg, 1764, says that Taisnier, a writer he quotes, saw in Spain, in 1548, two Greeks, who, before the Emperor Charles V., went under water in a weighted kettle. They could carry a candle inside this kettle, and so they descended into the water, where they could live for a considerable time. Such excitement is said to have been produced by this experiment, that 10,000 persons, on one occasion, witnessed it in the presence of the Emperor. Schott calls this the aquatic kettle, but speaks of another apparatus called the aquatic armor. Lord Bacon tells us that, in his time, there were means of diving in a similar manner, and he describes the mode in which it was done—a very primitive method, indeed. A tripod was fixed to a bell, and the bell was let down into the water. The tripod was weighted to keep it down, and when the man got to the bottom, he could come out of the chamber—holding his breath—pick up what he wanted, and then go back into the chamber and breathe again.

The Hon. Robert Boyle gives us a very singular narrative in one of his philosophical works. He tells that Cornelius Van Drebbel, a Dutch physician, a man of considerable mark, who has the credit of first constructing a thermometer, made, in the reign of James I., a submarine boat, in which a man could be submerged, and that actually the boat could be rowed by men that were inside it, beneath the water. The air, it is said, was kept pure, or resupplied by a fluid, carried by the men in the boat, which gave off something equivalent to the air, so that the men got fresh air from a liquid. The statement seems quite incredible, because in that day we cannot conceive any such thing as a fluid which would yield oxygen gas. In this day we have a fluid which is very rich in oxygen gas, the peroxide of oxygen, and when that is put into contact with substances which will set it free, we get oxygen in abundance. But this fluid was not discovered till 1818, when it was first made by the illustrious Thénard, the French chemist. However, a fluid of this kind would precisely answer the purpose described by Boyle. I could make an apparatus in which the oxygen would be supplied from a fluid in that way, but it would be very expensive. The peroxide is now used for a very different purpose; it is the fluid with which ladies stain their hair to a golden hue—the aureoline dye.

In the year 1678, we get a great improvement in the methods of diving, from the illustrious philosopher and astronomer, Halley. Halley reinvented the diving bell, but he went beyond that; he sent men with helmets on their heads out of the bell with tubes connected with the bell, so that they could breathe from the interior of the bell at a considerable distance from it. In 1776, Charles Spalding improved greatly on this method. He made a helmet and cuirass, and enabled men to descend into the water with great facility. I should say, as a matter of peculiar interest in this room, that Spalding received a "bounty" of twenty guineas from this society for improvements in diving and in the descent of men under water. Triewald, a Swede, first introduced lenses into the apparatus; before that tin, or flattened glass had been used. In 1748, Smeaton began to use a pump much after the manner of the present plans, which allowed the air to pass into the bell through a tube. Mr. Martin, in his "Philosophia Britannica," reports that a gentleman in Devonshire made a very ingenious diving dress, so constructed that it would hold half a hogshead of atmospheric air, in which a man could live under water a considerable number of hours. That may be an exaggeration; but the man could live a considerable time, and the

* A recent lecture before the Society of Arts.

inventor made a large sum of money by his invention. In 1798, Klingert invented tin plate armor, in addition to a leather jacket, and with that two pipes attached, one for inhaling and the other for letting out the air. This continued in use till 1829, when Mr. Siebe, whose firm is still, I believe, continued under the name of Siebe & Gorman, invented a diving dress, which consisted of a helmet and jacket which came half way down the body, and of trowsers which passed up under the arms. The helmet was supplied with air from above by a pump. When the man was in the water, the exhaled air passed underneath the jacket, and so into the water. That was called the open diving dress. It was very popular, and was not displaced even by another invention of Mr. Siebe himself without some objection by the old divers. Mr. Siebe afterwards invented what is called the closed diving dress. That is a helmet like this, with a cuirass and apparatus for injecting and extracting air.

We have no great advance or change in the method of diving dress until 1854, and then a Frenchman, named St. Simon Sicard, commenced to use compressed oxygen. My friend Captain Galton to-day told me that he was conversant with a method in which a bell was used with compressed air or oxygen in 1844. But keeping simply to the dress worn by divers under water, we come to 1854 before we get to St. Simon Sicard, who made a dress much after the manner of an ordinary diving dress, but he carried down with that oxygen gas compressed under six atmospheres. He also carried an apparatus by which he could remove the carbonic acid—so that he lived in an atmosphere of oxygen mixed with return air of oxygen and nitrogen from his lungs. He was not, I have been told, so successful in removing the water from the breath, and, therefore, the apparatus was imperfect. Those who used it were subjected to risk, and, for that reason, possibly, it was never brought into practice after the time of which I speak, and then only at various exhibitions. I am not aware that any deep diving was performed in Sicard's dress.

We now come to the dress I am going to bring before you to-day, which was invented by Mr. Fleuss, who is here, and who will show you all the details connected with it. He tells me, and I entirely believe what he says, that his invention was worked out step by step experimentally, and without reference to any previous invention. And as he has succeeded in removing the water of the breath, we may say that this dress is extremely complete.

In the first place, then, Mr. Fleuss has a helmet, and within that a chamber which is strong enough, he says, to bear a pressure of sixteen atmospheres if he likes to put on so much pressure. The space is one-fourth of a cubic foot in size, and, under pressure, he can introduce sufficient oxygen in the compressed form to last him for breathing purposes for five hours. He does not usually do that in his ordinary experiments; he introduces as much as will enable him to breathe, say for two or three hours. Before putting on this helmet, he puts on a cuirass (Fig. 1), and in which there are two metal chambers, one in front and one at the back. These metal chambers are fitted with small particles of porous India-rubber, which is so saturated with a solution of soda that it will absorb very rapidly the carbonic acid gas. After the cuirass is put on, and the dress which covers it, so as to shut off all water, he puts on an orinasal mask (Fig. 2), which is very ingeniously constructed, and adapts itself extremely well. It is a mouthpiece partly—not altogether—original. In the early days of anæsthesia, when we were beginning to use ether and chloroform, the late Dr. Sibson invented an orinasal mask for that purpose, which is nearly the same, and which fits very correctly. In administering the chloroform, the vapor was inhaled from one aperture, and the breath passed out through another, as you see here. I made, afterward, a mask very similar, which has been used a great many times, which differs only in that a valve, made of India-rubber, is placed above instead of at the side. Mr. Fleuss's mouthpiece is made of leather. It fits very tightly to his face, and has two valves, one on each side. These valves open inwards, so that in inspiration he draws the air inwards, and in expiration he breathes through this ingenious artificial windpipe. It is a very good imitation of a windpipe on a large scale, and he was very prudent in making it large enough, for we found originally we were much impeded by making too small a tube. Mr. Fleuss also found that in breathing there should be a large tube, and he has made it large accordingly. The mask is placed over his mouth and nose, and is tied firmly by a band which goes to the back of the neck. Its exit tube passes into one of these chambers containing soda within the cuirass. When he exhales, his breath passes down this tube into the first chamber, and over the soda, then through another tube within the cuirass, and through the second chamber, again over soda, finally it escapes at an opening near the shoulder into the helmet. In the process of breathing through these tubes, all the carbonic acid gas of the breath—all that is poisonous—has been removed, reserving something else. In breathing, we take in a certain quantity of oxygen with each breath, but we do not use the whole of it. There is a measure of *reserve* oxygen left, enough to sustain life for two or three minutes, if, from any accident, we are removed from the air. There is *return* oxygen—oxygen which has not been used in the lungs, and which goes back into the helmet, and is used again for breathing. In addition to that, there is the nitrogen which dilutes the oxygen in the ordinary atmosphere to the extent of four parts of nitrogen to one of oxygen, and that nitrogen, a negative substance, diluting the oxygen, all passes through these chambers and comes into the helmet. Mr. Fleuss has a tap in the helmet by which he can, when the helmet is adjusted on to the cuirass, admit oxygen freely, so that it can commingle with the nitrogen and the return oxygen. In this way, within the helmet, he is always making a new atmosphere for himself, and that is the principle of the invention. One other improvement he has made, which is a very important addition to previous attempts of a similar kind. He has a little space at the lower part of the soda chambers to receive the water that passes by the breath and is condensed. There is a perforated or false bottom below, and a trough into which the water of the breath falls, and so he is not impeded in expiring by the presence of water. The next best step in the process will be for Mr. Fleuss to show us how he charges the helmet. That is important, as proving how quickly he can charge it when it is exhausted. He can charge it sufficiently for all purposes of to-day in three minutes. The oxygen is brought, condensed in an iron bottle, by Mr. Orchard, of Kensington, and by a simple connecting tap and screw the helmet is charged from the bottle.

I refer specially to the simplicity of this plan, because I am anxious that the apparatus should be introduced into fire stations, for the purpose of enabling firemen to enter houses on fire, when it is of moment that a man should be able to get ready quickly. The condensation of oxygen in iron bottles has been brought to such perfection in these days that there ought to be no difficulty in always having a ready supply of oxygen, and you will see the rapid manner in which the helmet is charged. Any working man, after two or three days' practice, could learn to charge the helmet in a few minutes for any purpose for which it might be required.

The next step will be for Mr. Fleuss to put on the dress and show how he prepares himself. While he is doing that, I will narrate to you some of the experiments which he was kind enough to allow me to perform. I have to thank the managers of the Royal Polytechnic Institution for their kindness in first inviting me to see this dress, and for permitting me to perform experiments in the diving tank in their large hall. I first thought that Mr. Fleuss had some means of communicating with the outer air, but that theory was disproved, and then, from physiological knowledge, I easily discovered the way in which he carried out his operations. We soon understood each other, and began to work.

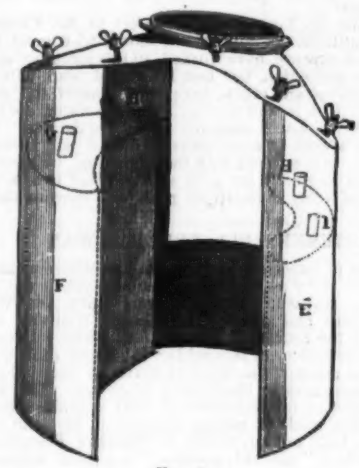


FIG. 1.

My object was to find out whether healthy life would be in any way impaired by living under these extraordinary conditions, in an atmosphere of oxygen artificially mixed with nitrogen. The first observation I made was on the 15th of November of last year, when Mr. Fleuss, in the course of one of his usual exhibitions in the tank, went to the bottom of the tank, and remained under water for an hour. The diving dress was adjusted at 6:33 P.M., and then Mr. Fleuss began to breathe through the apparatus. The question was whether the temperature of the body would be seriously affected by stopping for an hour under water, which, at this period of the year, was about 3° above freezing point. At the time he put on the dress, his temperature was quite natural, and his pulse was of good strength and tone, 72 in the minute. He said he felt the water colder lower down than he did at the surface. He descended at 6:40, and remained under water, at the depth of 12 ft., precisely one hour—that is, until 7:40. He walked about for the greater part of the time, picked up articles that were thrown into the water, and once or twice reclined on the floor of the tank. At the end of an hour he gave the signal to be drawn up, the coldness of the water having caused numbness in his hands. He walked up the steps, carrying the heavy weights of 116 lb. After a short delay, first the helmet and then the mouth piece were removed. I found the pulse 120 in the minute, and rather feeble; but there was no sign of suffocation, nor any symptom of danger. The breathing was quite free. The temperature of the body was 92° Fahr. He

FIG. 2.

attributed the quickness of the pulse to the labor of carrying the weights up the ladder, and that, no doubt, was correct. Seven minutes later, the dress was removed, and warm clothing put on. The pulse was then 90, and the temperature 94°. The natural temperature is 98·4°. Twenty minutes later the pulse was 80, and the temperature had risen to 96°, and very rapidly all the functions became again perfectly natural.

We have here a very remarkable experiment indeed, showing that a man can live, and apparently suffer no damage to his constitution, 6° below the natural temperature, for, in fact, he was at 92° when he first came up. I do not know how long that state could be maintained, because it is against previous knowledge and theory that for any length of time life can be maintained at that temperature. As regards the state of the circulation, I found that it was a little varied. I took readings of the pulse with a sphygmograph, and found it varied, but not materially. The pulse was made quicker and the strokes shorter, but not in any sense to cause a suspicion that there was any danger arising from the experiment. On the 25th of November I made another observation. I filled the diving bell of the Polytechnic Institution with carbonic acid gas, so that nothing could live in it a moment. A light was extinguished the instant it was put into the bell. Mr. Fleuss descended beneath the bell, and then ascended into it, and sat in it for the period of twenty minutes, quite protected from the effects of the carbonic acid gas. He was not affected in any way by that experiment. His temperature was 98° when he went into the bell, and his pulse 68; his temperature was 97¾° when he came out, and the pulse the same as before—68. I next thought it would be well to try if vapors, that were of a very much lighter character than carbonic acid gas, could be tested in a similar manner, whether they would in any degree permeate through the apparatus in such a way as to interfere with the success of the method. To test this, I charged the diving bell, still containing carbonic acid, with an atmosphere of amyl hydride—a very light gas, which passes into vapor below the temperature of the hand. No more crucial experiment could be tried. Mr. Fleuss entered the bell in this irrespirable atmosphere, remained twenty minutes, and then came out simply because the supply of oxygen began to fail. His temperature on going in was 98°, and his temperature on coming out was the same. His pulse was 72 on entering, and it was the same when he came out. In a word, he was unaffected altogether by an atmosphere the inhaling of which would have put any one who was unprotected to sleep, and probably to death in sixty seconds, but in which he lived for twenty minutes with perfect impunity.

There are some questions now which arise as to how long a man can live in an artificial atmosphere made in the manner adopted by Mr. Fleuss. I must confess at once that the atmosphere is not strictly natural when we compare it with that which we breathe ordinarily, because there is always an excess of oxygen in the helmet. Of that I think there can be no doubt. Mr. Fleuss himself has two modes of determining what quantity of gas he requires from the helmet. If he feels that he has pressure on the drums of the ears he knows he has too much gas. If he feels that he has a slight sense of suffocation, then he knows he has too little gas. By the regulating tap he lets in or lets out the gas at pleasure. He is living in an excess of oxygen gas; and some years ago it would have been said that that was a condition which was incompatible with life—certainly incompatible with healthy life—and a very curious volume of research would have to be followed out by the scholar to see how this has been discussed, independently of Mr. Fleuss's experiments. Priestley, who discovered oxygen gas, thought life could be sustained in it. Beddoes, who succeeded Priestley, held much the same opinion, but later on some experimentalists found that when animals were placed in oxygen gas, and lived in it for a considerable time, they went to sleep. One of the most distinguished members of the profession of medicine of this country, Sir Benjamin Brodie, in connection with Mr. Broughton, who, I believe, still lives, made a very elaborate series of researches on this question. They placed animals in a bell charged with pure oxygen gas, put potash water beneath a false shelf, and had an arrangement by which they could wash the air constantly with the potash water, so as to remove all the carbonic acid from the atmosphere. The animals placed in this condition went to sleep, and died away in a very gentle and pleasant sleep. So it got into the text books that oxygen gas is a narcotic poison, although not an irritant narcotic, killing with convulsions or other violent symptoms. But in my early career, in 1852, it occurred to me, on reading these experiments, that the experimentalists had not removed all the carbonic acid, and I thought that the carbonic acid was the cause of the sleep in these animals. To be quite sure of the matter, and to know how the experiments were performed, I called on Sir Benjamin Brodie, who was kind enough to see me, and he told me that, in his opinion, it was quite impossible that the animals died from carbonic acid, and he adduced the evidence of Professor Brande, of the Royal Institution, who had made an analysis of the oxygen from the chambers, and declared that there was no carbonic acid present. I then went to work in a different way to what had before been done. I placed warm blooded animals in small glass houses to breathe pure oxygen, but instead of removing the carbonic acid in the way above named, I passed the oxygen in a constant current through the houses in which the animals lived, so that the oxygen was always freshly supplied, and the carbonic acid was removed as it was formed. In this manner I found the oxygen was not a poison at all; at the ordinary temperature of 65° to 70° an animal would live just as well in this oxygen gas as in the common atmosphere. I found, however, that if there was a difference in the temperature—if the temperature were much lowered—then the peculiar sleep came on; while if the temperature were raised to summer heat, then there was an increased oxidation in the animal's body, so that a great deal of food was required, and wasting was very easily induced. Beyond these two facts of the influence of heat and cold, however, I found that oxygen gas was not a poison.

Curiously enough, another observation came before me. It was a very expensive experiment to make eighty or one hundred gallons of pure oxygen a day, and pass it through these chambers to be lost, so it struck me one day that I would save the oxygen which passed over from the chamber and would use it again. I therefore received the oxygen into another reservoir, after it had passed through the chamber in which the animals lived, and, having thoroughly washed it from carbonic acid, and every other foreign product that could be conceived, I use it again. To my great surprise, I discovered that, after being used twice in this manner, the oxygen lost the power of sustaining life so well as when freshly made. Why such should occur is yet a mystery. Whether some narcotic product is produced by the animal which diffuses through the oxygen, and which is not detectible, or whether the oxygen itself is changed in character by being breathed by the animals and exhaled, I cannot answer. But another result came out, and it was this: that if the oxygen which had been devitalized, to use a common term, were charged with electricity, simply by passing electric sparks through it from an induction coil, or a frictional machine, it immediately had restored to it its vital power, so that the animals lived as well then as they did in the fresh oxygen.

We may, therefore, say that, except under the extreme conditions of extreme heat and cold, Mr. Fleuss's system is a perfectly safe one for life, always supposing that he makes his oxygen fresh on every occasion, as he now does.

My researches on oxygen led me to another inquiry, viz., as to what was the use of nitrogen in the atmosphere. We know that nitrogen exists in the proportion of four parts to one, and the common impression has been that it is necessary in the air to dilute the oxygen, and that the oxygen would actually destroy life if it were not diluted. My theory is, that there is another intention for the presence of the

nitrogen—a theory I brought out in the year 1869. My idea is that nitrogen is present to meet the variations of temperature. For instance, if I took an animal from a temperature of 60°, and placed it not in cold oxygen, but in cold common air at 30°; if I fed it well, and covered its body closely; if, in fact, I placed it in the condition of a well fed Esquimau, I found the animal would want to take largely of food—would begin to make an excess of carbonic acid; and, if only fed as at 60°, would commence to waste. The reason for this is, that the oxygen is abundant in the air, and, at the same time, is sufficiently diluted to be able to combine with the blood and the tissues, and the result is a greater production of primary force, by which the animal is enabled, when well fed, to sustain the effects of the surrounding cold. If, from this extreme degree of cold, I move the animal to a temperature of 70°, still supplying it with common air, I find, if food be kept up, and all else be equal, the animal ceases to crave so much for food, produces less carbonic acid, and, with decreased waste, tends to grow fat. The reason for this is, that the oxygen diluted still for ready combination, does not meet the blood with the same degree of pressure, and the result is that the animal, which in the warmer medium does not require so free a production of force, produces less force. If, in repeating these experiments, I use pure oxygen instead of common air, the animal at the lower temperature will want no food, will make a minimum of carbonic acid, and will sleep and die from not burning; while the animal in the higher temperature will eat ravenously, get very hot, produce an excess of carbonic acid, and, if not largely supplied with food, would die from waste. The differences in the result of these experiments, as compared with those related before, are due to the absence of the equalizing nitrogen, which, existing in the proportion of four to one in common air, resists just in that proportion the excessive action both of heat and cold.

The practical application of these principles to Mr. Fleuss's apparatus is that there would be some degree of danger in using it in extreme cold or in extreme heat. The waste would be excessive in extreme heat, and that would lead to exhaustion. In long continued extreme cold the temperature of the body would go down, and there would be danger from that cause. I observed that was the case in the first observation made on Mr. Fleuss. The temperature went down to 92°, and the wonder was he could live so well in that temperature. Below that it would not be safe, in my opinion, to use this apparatus in the manner in which it is now brought forward.

For the use to which Mr. Fleuss's apparatus may be applied, I think some improvements admit of being made. It strikes me that a feeding apparatus might be introduced. Mr. Fleuss says he can live in it as long as he can go without food; and I think, if there were a bottle containing food —liquid meat, or milk within the cuirass, and a tube were passed upward through the mouthpiece, so as to come to the mouth, he might very easily take food and stop for a longer period under the water, perhaps for eight or ten hours. Another improvement which might be made would be specially useful for mines—that, viz., of having a telephonic arrangement, so that he could communicate with those above by means of connecting wires. Those are improvements which, I think, the apparatus will admit of in the future.

The conclusion we may arrive at is that we have an apparatus now at our command in which, under certain conditions, a man can live for a long time under water, and be capable of carrying out active movement with perfect freedom, in which also a person can enter into an irrespirable gas. The apparatus may be used for diving, but how far it will extend for that use exclusively has to be proved. There is a great difference, I understand, among divers as to the distance below water at which Mr. Fleuss can work with his apparatus. He himself has been 25 feet under water with it, and has felt no embarrassment. He has walked 400 yards under water and felt no embarrassment; but whether he can go to the great depths which some divers have gone with the ordinary dress, is a matter which remains yet for inquiry. It may interest you to know to what depths divers can go. Mr. Siebe has related that one diver, named Hooper, descended, near Cape Horn, actually to the depth of 200 feet, and remained working for forty-two minutes; the extremest depth to which a man has descended. That man, it is said, descended seven times, and remained under water forty-two minutes each time. The statement has not been confirmed by after experiments, perhaps because no one has had occasion to go to such a depth, but the very able writer of the article on diving in the "Encyclopædia Britannica" shows most distinctly that in some experiments made in Scottish waters, a depth of 86 feet was attained by the divers; so that we may be quite sure, from the observations then made, that 86 feet is an attainable depth. On theoretical grounds, Mr. Fleuss ought to do the same, but he has yet to win his spurs to show that he can descend to that depth, and perform work the same as divers can who are supplied with air through a tube from above.

Whether the invention is to be useful in the way of a diving apparatus or not, certain it is, it may be very useful for many other purposes. It may be extremely useful, I think, for entering into houses that are on fire, and my suggestion will be that a dress be made of very light material for this purpose, and of a fireproof material. That is to say, perhaps a felt dress, saturated in nephate of ammonia, and made in such a way that the limbs can move easily in it. Then I see no reason why a man should not enter into a burning house and fetch out persons who are being burnt or subjected to danger, without any danger at all, in so far as the bad air is concerned. Of course he could not resist great heat, nor the danger from falling materials, but he would resist the suffocating smoke and air. I believe that this will be one of the most admirable contrivances, and I should expect that the day will come when every fire engine room in London will be supplied with one of them. Again, I think the apparatus may be used with great effect in mines. I have already shown, by an experiment with Mr. Fleuss, in the most crucial form, that he can live in the most active narcotic atmosphere. That he could be let down into a mine at any time after an explosion and traverse wherever he could see, and ascertain what persons were there, and render assistance, I have not the slightest doubt. He could do that to any extent, if he could carry a light. There an improvement wants to be brought forward again, a light that will illuminate all round, and yet, at the same time not set fire to explosive gas. Once more, he could enter wells and places where carbonic acid is being given off freely. The dogs in the Grotto del Cane die rapidly when they are put on the floor; Mr. Fleuss could lie down in the place all day, if he could feed himself quite safely.

In conclusion, let me put before you one demonstration. I have been favored by the Royal Institution with the loan of the glass chamber in which Professor Tyndall made the experiment of entering into smoke, using a filter mask over his mouth. That chamber, which has, I suppose, a capacity of about 45 cubic feet, has been charged with carbonic acid. The whole of the atmospheric air in it may not be removed, but like the lower part of the Grotto del Cane, nothing could live in it. Mr. Fleuss will, however, go into it, and set us at defiance, for he cares nothing about an atmosphere of that kind.

[Mr. Fleuss went into the chamber of carbonic acid gas, and remained a considerable time.]

There is one further advance which will probably be made on this, and that will be to fit up a small submerged vessel with propelling power, so that men may live in it under water and pass beneath the sea considerable distances, carrying with them their own atmosphere and food. When I once said that a great branch of geographical discovery made by the Salutlanders was the exploration of the floors of the great depths, I was very much laughed at; now, I think the laugh is going to be on my side, and that that achievement will even come to pass in the course of the next half century.

It remains, sir, for me only to express to Mr. Fleuss our debt of gratitude, not only that he should with great labor, trouble, and expense, have worked out this ingenious apparatus to such perfection, but that he should, also, with true English courage and pluck, have been himself the first to experiment with it, and to enter into deep water, not knowing whether he should come out alive from the trial. It has been to me a work of much pleasure indeed, and I esteem it an honor to be connected with this apparatus, by giving the first lecture on what I am quite sure will lead to a new era in the art of living in factitious gases, and beneath the sea.

SIEMENS' ELECTRIC RAILWAY.

The idea of superseding the steam locomotive by an electric engine is by no means a novel one; but it was never practically realized until last year, when Dr. Werner Siemens built and operated an electric tramway in the grounds of the Industrial Exhibition at Berlin. In connection with the history of this subject it is worth while to mention that an attempt was made to devise an electric locomotive in America some thirty-three years ago. The Scientific American for September 25, 1847, contains a description of a new mode of railway propulsion, the joint invention of Mr. Lilly and Dr. Colton, of Pittsburg, Pennsylvania. "The machine," says this account, "is a small locomotive, and is placed upon a circular railway, around which it is driven by electricity. The power is applied not to the locomotive, but to the *track*, in a very curious manner. Two currents of electricity, negative and positive, are applied to the rails, and by them communicated to the engine. The latter is provided with two magnets, which, by a process of alternate attraction and repulsion, drive the car over the track. A piece of lead is placed on the locomotive, making in all a weight of 10 lb., and on the application of the battery the machine moved with astonishing rapidity up a plane inclined about 5°." In this apparatus the current was supplied by a battery, a fact which, together with the imperfect state of electric science at the time, doubtless caused its failure.

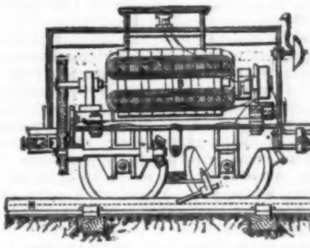
Another claimant for priority of invention of the electric railway is M. Boué, *sous-intendant militaire* at Belfort, in France. This gentleman took out a French patent in 1878 for the propulsion of carriages on a railway by means of electricity; and not only does the patent describe a means for driving a single train of cars, but also a vibratory apparatus whereby the power of the current may be distributed to several separate trains so as to propel them all. Perhaps, too, we ought to mention that Mr. Edison has of late been relieving his severer labors by the erection of an electric railway, on which it is his delight to whisk admiring visitors along. Curiously enough, he also intends to build a line at a very steep gradient (1 in 6) in order to show the capabilities of his electric railway for overcoming inclines. We say curiously enough, because that is one of the purposes which Dr. Werner Siemens has expressly stated that the new electric train would be adapted to.

Historical mention is justly accorded to the pioneers of a new invention, though the chief merit rests with him who makes it a success. To Dr. Werner Siemens belongs the honor of recognizing that the improved means now at our disposal for generating electricity and applying it to the transmission of power are sufficient to operate an electric railway on a practicable scale.

The Berlin Railway was a narrow gauge line, laid down in a circle 900 yards long. A train of three or four carriages was placed upon it, and on the first carriage a medium-sized dynamo-electric machine was fixed to the axle of one pair of wheels in such a manner as to rotate the wheels when the armature of the machine was rotated by the passage of a current through its coils. The rails were laid upon wooden sleepers, which, even in wet weather, insulated the rails very well for this length of line. A third rail ran between the other two, and it was by this central conductor that the current was led from the generating machine placed at one terminus of the line. The current was drawn from this rail to the armature of the machine on the locomotive by means of a brush of copper wires; and after traversing the coils of the armature it was led to the axle of the driving wheels, which was insulated from the body of the car, and thence by the driving wheels to the outer rails, and by them back to the dynamo machine at the terminus. The annexed figure represents a section through the locomotive, showing the dynamo-electric machine, B, and the central rail, N, with the metal brush for abducting the current.

Between twenty and thirty persons could be accommodated on the train at a time, including the conductor, who rode on the first carriage; and during the course of the summer no fewer than 100,000 were conveyed over the line at a speed of from fifteen to twenty miles an hour. Crowded trains left the stations every five or ten minutes, and a considerable sum was earned in this way for the benefit of charitable institutions. The locomotive was capable of exerting five horse power, and instead of being fitted with a steam valve like a locomotive to start or stop it, it was simply provided with a commutator for closing or opening the circuit of the current.

"It is," says Dr. C. W. Siemens, "a remarkable circumstance in favor of the electric transmission of power, that while the motion of the electro magnetic or power-receiving machine is small, its potential of force is at its maximum, and it is owing to this favorable circumstance that the electric train starts with a remarkable degree of energy. With the increase of motion the accelerating power diminishes until it comes to zero, when the velocity of the dynamo or driven machine becomes equal to that of the dynamo or current-producing machine. Between the two limits of rest and maximum velocity the driving power regulates itself according to the velocity of the train; thus, on an ascending gradient the speed of the train diminishes, but the same effect is automatically produced which results from the turning on of more steam in the case of the locomotive engine. When running on the level, the velocity of the train should be such that the magneto-electric machine should make one-half to two-thirds of the number of revolutions per minute of the dynamo-electric machine. When descending, the speed of the magneto-electric machine will be increased in consequence of the increased velocity of the train, until it exceeds that of the dynamo-electric machine, from which moment the functions of the two machines will be reversed; the machine on the train will become a current generator, and pay back as it were its spare power into store, performing at the same time the useful action of a brake in checking further increase in the velocity of the train. If two trains be placed upon the same pair of rails, the one moving upon an ascending portion, the other upon a descending portion of the same, power will be transmitted through the rails from the latter to the former, and they may, therefore, be considered as connected by means of an invisible rope."



With regard to the relations of work done to energy expended on the electric railway, the proportion of power actually transmitted varies with the speed of the train, and reaches a maximum when the angular velocity of the armature of the machine on the train is about two-thirds that of the armature of the current generator. Under this condition it is found in practice that something over fifty per cent. of the motive power of the stationary engine driving the generator is utilized in drawing the train.

It is not to be expected that the electric locomotive will compete with the steam locomotive on long lines of railway, any more than the electric light will at present rival gas for general use, but it may prove very serviceable under special circumstances and on short lines. For steep gradients, tramways in mines, docks, large works, or cities, it is particularly well adapted, owing to its freedom from noise or noxious fumes. It is also well adapted for the transmission of letters along subterranean tubes; and we understand that experiments are being made in Paris with a view to supplanting the pneumatic system of carrying letters by an underground "electric post."

A more important project, however, is the scheme of Dr. Werner Siemens for an elevated tramway to connect one end of the city of Berlin with the other. It is proposed to have two separate lines, one for the going and the other for the return journey. The rails are to be 3 ft. 3 in. apart, and only two rails will be required for each line, the current coming from the terminal engine by one line, and returning by the other. Each train has fourteen narrow cars, four to convey standing passengers, and ten for sitting passengers. A 60-horse power engine will be stationed at one end of each line, and the speed will be twenty miles per hour. A good deal of opposition to the project has been offered by the owners of property along the route under the impression that it will depreciate the value of their houses, and a commission has been appointed to examine these objections.

The freedom of the electro-locomotive from smoke is of great importance in passing through a long adit or tunnel, and it is interesting to learn that the administration of the St. Gothard Tunnel seriously contemplate its application to the conveyance of their trains through that gigantic tunnel. Existing circumstances are in this case favorable to the employment of electric power, for at both ends of the tunnel turbines of enormous aggregate power were established to assist in boring, and still stand ready for use. All that has to be done, therefore, is to insulate the rails, and connect up dynamo-electric machines of sufficient power to the turbines and the train. Instead of insulating one of the rails, it might be advisable to convey the current by a conducting rope resting on wooden or glass supports in such a manner that it can be picked up by the train as it passes, and run over one or more contact pulleys connected to the armature of the machine carried by the train, then deposited again on its insulating supports. In this way, no doubt, the insulation of the rails could be avoided, but it remains to be determined by the experiment whether the high velocity of the train would not render such a plan impracticable.—*Engineering.*

NEW APPLICATIONS OF THE DYNAMO-ELECTRIC CURRENT.

So long as the production of electricity was confined to voltaic batteries and small imperfect magneto-electric machines, the use of electric currents was necessarily much restricted. In fact they could only be employed in cases where the mechanical or other sensible effects were small, such, for example, as the electric telegraph, and those devices in which purely mechanical arrangements would have been too cumbrous or otherwise impracticable. The improvement of the dynamo-electric generator, however, enables the electrician to deal with very powerful currents, and accomplish work on a massive scale. Even in telegraphing the dynamo-electric current is supplanting the voltaic battery for supplying the electric power, and the colossal Western Union Telegraph Company of the United States now transmit all the messages from their central office in New York by the currents drawn from four Siemens machines. The recent success, says *Engineering*, of the electric light is another triumph for this mode of generating electricity, and the new applications we are about to describe open up to our view a vast horizon of possible uses in the future.

The name of Siemens is in the front of this advance, and will ever be associated with the industrial capabilities of the electric current. It is to Dr. C. W. Siemens that we owe two of the most recent uses of the current, namely, the fusion of refractory metals in considerable quantities in an electric furnace, and the promotion of vegetation under the action of the electric light. To Dr. Werner Siemens, of Berlin, we

are indebted for a third application, which promises to become very widely extended: we mean the propulsion of cars along rail or tramways by the dynamo-electric current, and, in general, the driving of machinery.

The chief results of these three applications which have as yet been obtained were communicated by Dr. C. W. Siemens to the Society of Telegraph Engineers at a special meeting on June 3, and we shall now proceed to review them.

FUSION OF METALS BY ELECTRICITY.

Taking up the subject of electric fusion first, perhaps because it is the most novel of the three applications, Dr. Siemens remarked that the oxyhydrogen blast was the most used, especially the form of M. St. Claire de Ville, known as the "Deville furnace," which has been applied by Mr. G. Matthey, F.R.S., for the fusion of considerable quantities of platinum. The regenerative gas furnace, now used for the production of mild steel, is another plan for creating extremely high temperatures; and by the application of the open-hearth process from 10 to 15 tons of malleable iron, containing only traces of carbon or other alloy, may be seen on the open hearth of the furnace in a perfectly fluid state, and at a temperature probably equal to the melting point of platinum. The only building material capable of withstanding so fierce a heat is a brick composed of 98·5 per cent. of silica and only 1·5 per cent. of alumina, iron, and lime, to bind the silica together.

The degree of heat attainable, either in the Deville or the Siemens regenerative furnace, is, however, limited to the temperature of dissociation of carbonic acid and aqueous vapor, that is from 2,500° to 2,800° C. It is, therefore, to the electric arc that we must look for the production of temperatures exceeding the dissociation point of the fuel employed in combustion furnaces. The germ of this application lies in the decomposition of potash by Sir Humphry Davy in 1807, and the discovery of the electric light by the same philosopher in 1810. Spectroscopists have found the value of the arc in dissociating elements, and quite recently Professor Dewar employed the dynamo-electric current to vaporize metals in a crucible of lime. Nor should we forget that Mr. Werderman once patented a plan for fusing blast holes in hard rock by means of the electric arc, thus obviating the use of diamond drills. But Dr. Siemens is, we believe, the first to produce what may be called large effects of intense heat by the same means.

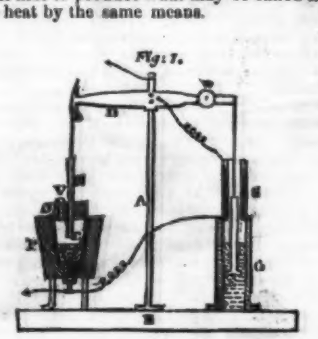


Fig. 1 illustrates the Siemens electric furnace. It consists of an ordinary crucible, C, of plumbago, or other highly refractory material, inclosed in a metal casing holding a packing, F, of pounded charcoal, or other bad conductor of heat. An electrode, P, for the positive current of iron, platinum, or dense carbon enters the crucible from below, and a negative electrode, N, of compressed carbon enters from above by the lid, L, in which is pierced a vent, V. The negative electrode, N, is hung from the end of a beam, D, by a strip of copper. The beam is supported by a stand, A, fixed on a base, B, and carries at its other extremity a hollow cylinder of iron, E, with a piston end. This core is free to move up and down within a solenoid of wire, S, when attracted more or less by the current circulating in the latter, and the water contained in the barrel, G, gives a stability to its motion. A weight, W, can be slid on the beam so as to balance the magnetic pull on the core in the solenoid. The solenoid is a coil of 50 ohms resistance, and it is connected up as a derived or "cut-off" circuit to the main circuit through the arc; therefore, if the arc should become too wide, and consequently the arc current too small, a stronger current will traverse the solenoid or by-circuit and pull up the iron cylinder. This will have the effect of raising the solenoid end of the beam and lowering the carbon, N, further into the crucible, thereby bringing back the arc to its proper width. As the temperature of the crucible is always rising a regulating action of this kind is necessary, for the resistance of the arc correspondingly diminishes, and the length has to be increased. Moreover, the sudden sinking of the melting charge occasions equally sudden variations in the length of the air-gap across which the current has to pass.

An important element in the success of the electric furnace is the employment of the material to be fused as the positive pole, or that pole where most heat is developed. This course will, however, only be available with metals or conducting ores, and when non-conductors are to be fused it will be necessary to employ a positive pole of platinum or iridium, which may melt into a pool at the bottom of the crucible. The use of a dense carbon for the negative pole incurs the objection that particles of the carbon may adulterate the charge, but the consumption of the negative pole in a neutral atmosphere is usually very slow. To guard against any impurities of this nature, however, Dr. Siemens has devised a non-wasting pole formed of a copper tube cooled by an interior circulation of water.

From theoretical considerations Dr. Siemens finds that the effective heat attainable in the electric furnace is one-fifteenth of the heat energy residing in the coal consumed under the boiler of the engine driving the dynamo-electric machine. It follows from this calculation that one pound of coal is capable of melting an equal weight of mild steel in the furnace. Now in the ordinary Sheffield air furnace it takes three tons of best Durham coke to melt a ton of mild steel in crucibles, whereas with the regenerative gas furnace, one ton of coal suffices to fuse a ton of steel in crucibles, and on the open hearth of this furnace 12 cwt. of coal will produce one ton of steel. The electric furnace is, therefore, more economical that the ordinary air furnace, and but for some incidental losses of heat would nearly be as economical as the gas furnace. Practically, with a medium-sized dynamo-machine, capable of producing a current 36 webers in strength with an expenditure of 4-horse power, a crucible 8 inches deep is raised to white heat in less than half an hour, and over 2 lb. of steel can be fused in the same time. At the Society of Telegraph Engineers, with a current of 70 webers, Dr. Siemens fused the same quantity of broken files in about fifteen minutes, starting with a cold furnace. Indeed, the files were poured out in a molten state before the crucible was hot. It is almost needless to say that succeeding fusions in a heated crucible could be effected in a shorter time.

For melting the precious metals, for effecting the reduction of refractory ores, and the dissociation of chemical substances, the electric furnace will doubtless prove useful, inasmuch as it is capable of providing a temperature theoretically unlimited and a neutral atmosphere. Moreover, the operation may be conveniently carried on in the laboratory without much preparation; and very high temperatures may be attained with ordinary crucibles, owing to the fact that the heat of fusion is directly brought to bear on the material to be fused rather than the crucible itself.

GROWING PLANTS BY THE ELECTRIC LIGHT.

The extreme temperature of the electric arc and its peculiar blistering effect, which, like burning sunshine, it exercises upon the skin, first suggested to Dr. Siemens that its action on vegetable life might be analogous to that of sunlight. Curiously enough the use of the electric light for forcing fruit and flowers was independently suggested nearly two years ago by a writer in *Cassell's Magazine*. In fostering vegetation the solar radiance produces chlorophyl, the matter which gives a green color to the leaves of plants, and also effects within the vegetable cell the decomposition of the carbonic acid and aqueous vapor inhaled by the leaf from the atmosphere, thus supplying the plant with starch and carbon to build up its woody tissues. The electric arc is a kind of miniature sun emitting rays of almost every refrangibility, and hence it is not surprising that Dr. Siemens should have found it act like solar light in producing chlorophyl and decomposing carbonic acid and water in the leaves of plants. Some of his results, however, are very interesting, and could not have been predicted.

The experiments were made at his country residence of Sherwood, near Tunbridge Wells. The apparatus employed consists of a vertical Siemens dynamo machine of small size, making 1,000 revolutions a minute under a driving force of 2-horse power, and developing a continuous current of about 26 webers, having an electro-motive force of 70 volts. A 3-horse power Otto silent gas engine was employed to generate the driving power; and the light was obtained from a Siemens regulator lamp, having two carbons of 12 and 10 millimeters diameter respectively. This lamp yielded a light equivalent to 1,400 candles.

In the first experiment made by Dr. Siemens the electric lamp was placed about 7 feet above the outside of a sunk melon-house, and fitted with a reflector to throw the light down on the sash. Pots of quick-growing seeds, such as mustard, carrots, melons, etc., were brought at stated intervals under the influence of solar or electric light, or both combined, and others were kept in the dark. The results showed that the plants kept in the dark were pale and sickly, those exposed to the electric light alone had a light green tint and considerable vitality, those kept under sunlight alone were of a darker green and greater vitality, while those exposed to both sources of light were decidedly superior to the rest both in hue and vigor. Judging from this experiment, the power of sunlight is about twice as great as the electric light for purposes of growth; but it was clear that the electric light was not placed so as to give its full effect, owing to the globe round the lamp and the moisture condensed on the frame.

To overcome this loss of power, Dr. Siemens next arranged the lamp within the melon-house, at the same time darkening the sash outside with thick matting and whitewashing the walls inside. And here to prevent scorching of the leaves it was necessary to keep the plants four or five feet from the light. Some of the plants were exposed only to day light, others only to the electric light during eleven hours of night, and others had the full benefit of daylight, followed by the electric light at night. The result showed that the daylight plants were healthier and greener than the electric light ones, but those subjected to continuous light were the richest and strongest of all. A striking token of the efficacy of the electric light in forcing flowers was likewise afforded by a pot of tulip buds which opened into full bloom after an exposure of about two hours.

"Another object I had in view in this experiment," says Dr. Siemens, "was to observe whether the plants were injured by the carbonic acid and nitrogenous compounds observed by Professor Dewar to be produced within the electric arc. All continuous access of air into the stove was stopped, and, in order to prevent excessive accumulation of heat, the stovepipes were thickly covered with matting and wet leaves. But although the access of stove heat was thus stopped, the temperature of the house continued through the night at 72° Fahr., proving that the electric light furnished not only light, but sufficient heat also. No injurious effect was observed on the plants from want of ventilation, and it is probable that the supply of carbonic acid given off by the complete combustion of the carbon electrodes at high temperature, and under the influence of an excess of oxygen, sustained their vital functions. If nitrogenous compounds were produced in large quantities it is likely the plants would have been injured, but they could not be perceived by their smell in the stove when all the ventilators were closed, and no injurious effects on the plants have been observed." To these remarks it may be added that the invigorating effect of the light seems to counteract the withering influence of stove heat.

The electric lamp was next placed in the interior of a conservatory in the corner, and as high as possible, so that its rays might fall on the plants at the same angle as the solar rays at noon, a condition which was fulfilled in all its experiments. Young vines, nectarines, roses, geraniums, and orchids were placed on the floor at various distances from the light. The temperature of the hothouse was maintained at 65° Fahr., and the lamp was kept lit from 5 P.M. to 6 A.M. for one week (February 18 to February 24), excepting Sunday night. It was then seen that the plants nearest the light had made most progress; but all exhibited an increased vigor, and the flowers were manifestly brighter than they otherwise would have been. Moreover, the scenic display of the vivid foliage under the enhancing radiance of the arc was very fine.

The effect of the light on plants in the open air was also tried, and Dr. Siemens is of opinion that flowering plants thus grown are brought forward even more rapidly than by daylight. The heat given off by the arc, too, would seem to ward off night frosts, and it is probable that the buds of wall fruit may be saved by this means from the nipping cold of spring.

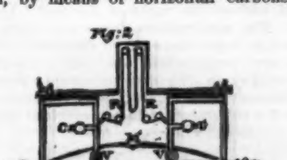
It is clear, then, from these experiments, that the growth and flowering of plants is promoted under the stimulating influence of the electric light; and it is put beyond a doubt, too, that plants can grow continuously. The experience of arctic summers, during which the sun never sets, is evidence in favor of this view, and, according to the experiments of Dr. Schübeler, of Christiania, plants develop more brilliant flowers and larger and more aromatic fruit when exposed to continuous light than when they experience alternations of daylight and darkness. Some botanists assert that plants grow chiefly in the night time, but these experiments demonstrate that growth takes place by day as well as night, and that exposure to continuous light will produce the finest flowers and fruit, whether the light be wholly electric or part electric and part sunshine. Perhaps, however, it would be advisable to investigate this question further in case it should be found that short intervals of rest were really favorable to the healthy growth of the plant.

The efficacy of the electric lamp in forcing fruit has also been studied by Dr. Siemens, and it is clear that it possesses the power of forming the sugar and aromatic essences of ripening fruit. A pot of strawberries kept for ten days under continuous illumination by solar and electric light showed clusters of rich red fruit of a most luscious flavor and delicious fragrance, while similar plants kept under daylight alone exhibited only green berries. It is probable, therefore, that early grapes, peaches, and other fruit will be forced during our dark foggy winters by the electric light, which will render our gardeners to some extent independent of the sun.

The practical success of artificial lighting in horticulture will, of course, depend largely on its cost; but Dr. Siemens thinks that the medium-sized machine, which gives a light of 6,000 candles, with an expenditure of 4-horse power, will be economical. The lamp would require to be fixed 20 feet above the plants, and if the surface to be illuminated were large the radiating centers should be placed at distances apart equal to twice or thrice their distances above ground, so as to blend the light into sensible uniformity; for a square foot of surface midway between would receive from each center one-half the number of rays falling upon the same area immediately below a center. Nine lights so placed would illuminate about three-quarters of an acre. A brick wall surrounding this area would receive the benefit of the light for forcing fruit, and would screen off cold winds, as also would the vertical glass partitions of Sir William Armstrong. To maintain this illumination a 36-horse power engine would be required. This would consume 90 lb. of coal per hour, which for a night of twelve hours, with 40 lb. for getting up steam, amounts to 10 cwt., costing, say, 8s. per night. To this must be added the cost of carbons and an attendant, making a total of 16s. per night. If, however, the engine could be utilized for other work by day, or, better still, the waste power of a waterfall employed, the cost would be very much less. The 1,400 candle light used by Dr. Siemens himself costs about 5d. per hour, including carbons, but exclusive of attendance. Such a light at 7 feet distance is about equal in effect to the average daylight of February; but the larger lights are more economical.

To test this question on a working scale, Mr. Siemens is having a 6-horse power horizontal Soho engine, made by Tangye Brothers, and a Cornish boiler laid down at Sherwood for the purpose of driving two medium machines, giving a total light of 12,000 candles. The steam, after actuating the engine, will be used to heat the hot-houses, and it is expected that little more fuel will be needed than was formerly required to warm the flues. The engine will be further utilized by day in turning the machines for cutting wood, chaff, and turnips at the home farm, a quarter of a mile away, by means of a dynamo-electric machine. With this apparatus Dr. Siemens also proposes to ascertain what rays of the spectrum produce chlorophyl, starch, wood, and sugar, by exposing plants in a darkened chamber to the actinic, optic, and thermal rays of a spectrum of the electric light.

The lamp to be used in these experiments is shown in Fig. 2, which, by means of horizontal carbons, P N, provides a fixed focus, and allows the rays to be projected downward by a parabolic reflector, M. The carbons are contained in brass tubes, supported by four rods, and they are pulled together by means of two volute springs, V V, and cords. On the other hand, they are also drawn apart by the regulator so as to form the proper arc. The regulator consists of a thin ribbon of copper, R R, passing over pulleys, as shown. This copper tape forms a by-path or derived circuit to the main circuit through the arc, so that when the arc is too wide a stronger current traverses the by-path, thereby heating and consequently expanding it. The result is that the tape is slackened on the pulleys and the counterpoises, C C, act so as to allow the springs to pull the carbons nearer together and diminish the width of the arc to its proper value.



OBELISKS AS LIGHTNING CONDUCTORS.

Mr. F. Le Page Renouf, a student of the Coptic language, writes as follows to the *Academy:* "A good deal was written some time ago on the subject of obelisks. I am not aware that attention has ever yet been called to an important piece of evidence as to the use of this kind of monument. This evidence is found in an inscription from the temple at Edfu, published by Brugsch Bey in the *Zeitschrift für Aegyptische Sprache*, September, 1875. In the thirty-fourth line of this text 'two large obelisks' are expressly said to have been constructed, *her tekes shena enen en Nu*, 'for the purpose of cleaving asunder the storm-cloud of heaven.' Brugsch had already, in the *Zeitschrift* of 1871, p. 143, quoted a similar text in reference to the great flagstaffs of the pylones."

As a general rule, M. J. Reiset finds from what appears to be a very accurate method, that in 100,000 parts of atmospheric air there are 29·78 parts by volume of carbonic acid. At any time the relation of carbonic acid to the other constituents of the atmosphere does not vary very much, but it is slightly more abundant by night than by day, and in foggy than in fair weather, though by no means to such a degree as to be serviceable for meteorological purposes.

THE BRUSSELS NATIONAL EXHIBITION.

THERE have been great festivities this year in Belgium to commemorate the jubilee of Belgian independence, it being just fifty years since the good citizens of Brussels raised the standard of revolt against Holland, and driving Prince Frederic, the king's son, who commanded the troops, from the city, declared their country independent, and elected a provisional government. The festivities were inaugurated on the 15th of June, by the opening by the king and queen of a grand National Exhibition, a handsome structure which has been built on the Champs des Manœuvres, and which contains chiefly exhibits of what Belgium and the Belgians have produced, either in the way of manufactures or of inventions or of art, since 1830. The *façade* of the building, as may be seen in our sketch, chiefly consists of two pavilions, united by a semicircular colonnade, in the center of which stands a triumphal arch. In these pavilions, among other things, will be found a curious exhibition of specimens of the manufactures and art products of bygone ages—such as jewelry, furniture, costumes, porcelain, carpets, armor, coins, etc., all of which will be curious and interesting to compare with similar articles of the present day. Foremost among modern exhibits are objects relating to education, and in those at least we moderns may boast of having achieved a vast improvement. Behind the pavilions and the arcade are numerous temporary buildings containing exhibits and collections of various kinds, ranging from leather and pottery to railway carriages and fruits and vegetables. The applications for space have been great, and there are no fewer than seven thousand exhibitors. The gardens are very prettily laid out, and, together with the buildings, occupy an area of some seventy thousand square meters. The cost of the Exhibition is estimated at £48,000. Our sketch is a reduction from the original plan of M. Bordiaux, the architect.—*London Graphic.*

THE JUBILEE OF BELGIAN INDEPENDENCE.—THE NATIONAL EXHIBITION BUILDING AT BRUSSELS.

RAWDON HOUSE, HODDESDEN, ETC.

AMONG the architectural exhibits this year at the Royal Academy are the four drawings given opposite, by Ernest George and Peto, Argyle Street, W. Rawdon House, Hoddesden, is an interesting old building, bearing the date 1622; to this the architects have been adding a wing for Mr. Henry Ricardo, the owner. The choice of material had to be made in adding to a building that had been ruthlessly stuccoed. On peeling off the cement from the old work, interesting brick mouldings and pilasters were exposed; and great care has since been taken in bringing again to light the red-brick walls which fixed the character of the new work. The house stands back some seventy feet from the high road. It was decided to add the additional rooms in a wing between the house and the road, forming a courtyard in front, with a gateway to the stables, and covering the site of a recent badly-built extension, which was out of character with the old house. The new wing contains a dining room, schoolroom, nurseries, and bedrooms, and a lift from the offices, and other such conveniences, of which the old house was innocent. The billiard room is oak paneled, after the manner of the original rooms. A sundial makes a pleasing feature on the south front of the new wing, and the new and old work blend harmoniously. The new building and works to old front have been very satisfactorily carried out by Mr. Hunt, of Hoddesden, at a cost of between four and five thousand pounds. Mr. J. B. Gass, of Bolton, has had charge of the works, and has shown great care in their superintendence.

A house at Westgate-on-Sea is another work by the same architects, and is now erecting for Mr. Herbert Peto. The house is situated with a fine view of the cliffs and sea, in one of the healthiest positions of this healthiest of seaside places. The plan is compact and square, though the squareness is lost on the ground floor by the large bay windows toward the sea, and the roof is rendered interesting with picturesque gables. The rooms are grouped around a paneled hall, with a fireplace and deeply recessed windows. The dining room has an ingle nook, lined inside with gauged brickwork, and has settles on either side. The long range of windows at the top light a good playroom and schoolroom for the children. The stables are at a short distance from the house. The buildings are of red brick, with weather tiling, and the gables are filled in with plaster modeling by Mr. Walter Smith, of Lambeth; the brickwork is built in cement, and the external walls are hollow, with Jennings' borders, as no solid wall would keep out the seadamp. The house is being erected by Messrs. Peto Brothers, at a cost of about three thousand pounds.

Woodhouse, for Sir George Baker, Bart., is now building at Uplyme, Devon, near Lyme Regis. It is beautifully placed on rising ground, in one of the loveliest coombes of this part of Devonshire, with a fine view over the Lyme Bay, and is situated near Rousdon, a large work just completed for Sir Henry Peek by the same architects. The ground story of the building is of random-coursed Uplyme stone, built hollow, with brick lining. The upper portion of the building is of timber, boarded and felted over and covered with weather tiling. The gables are of oak timber work. The contract was taken in competition by Mr. Luscombe, of Exeter, for the sum of four thousand five hundred and twenty-five pounds.

The Lodge, near Pinner, for Mr. Lawrence Baker, is built on the site of the former one that was frequently inundated by the rising of the Pinn. The present lodge is built upon arches, under which the water may rise without doing mischief. The posts of the porch have been cleverly carved by Mr. Hitch. The ornamental plaster filling-in of the timber work is from the hands of Walter Smith. This lodge, and the group of three cottages, have been built by Mr. J. Kindell, of Harrow.—*Building News.*

HOUSE DRAINAGE.*

WHEREVER the water-carriage system is used for removal of excreta, it is very desirable that sewers should also be provided. But as many suburban communities may not yet have provided sewers, and many good houses are frequently being built in isolated places where sewers cannot be expected to be constructed for a long time, it becomes important to consider the best substitute for sewers in such cases. The ordinary way is to dig a hole in the ground and line it with loose stone or honeycomb brickwork, into which the sewage may be led, and from which it is hoped it may soak away into the soil and be out of sight. Where the soil is very porous and the surface sloping away from the house, this method may succeed for some months, and even years, without much risk to the house, *provided* this cesspool is far enough from the house to prevent its odors from being carried back through the air, and provided pains be taken that the gases evolved by the decomposition always going on within the cesspool shall not be conducted back into the house through the drain pipe.

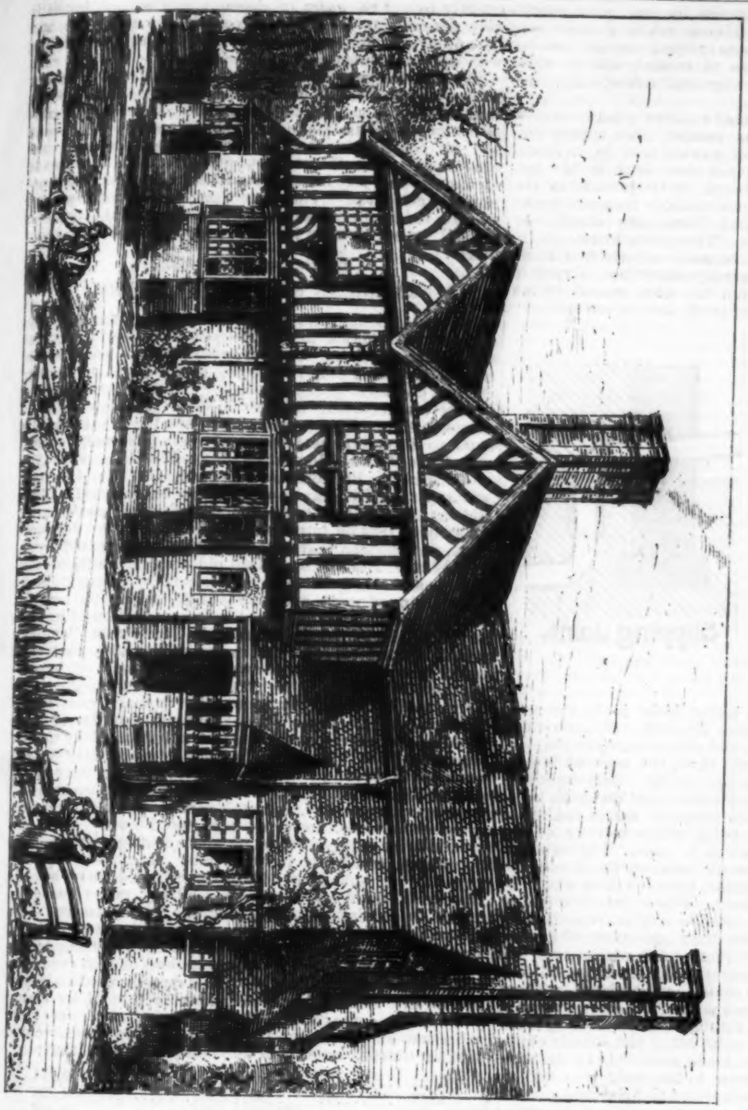
But this method can never be satisfactory. The great risk of all such contrivances is the contamination of the soil and the drinking water, where this is drawn from wells or cisterns on the same premises. Dr. C. F. Folsom, Secretary of the Massachusetts Board of Health, relates in the *Medical and Surgical Journal* for March, 1880, that a well which he tested was proved beyond a doubt to be contaminated by a privy vault one hundred feet distant, the well being sixteen feet deep. There was no unusual taste in the water, but suspicion had been directed to it from typhoid fever among those who drank its water. It follows, then, that all porous cesspools must be condemned. They store up the filth in the soil just deep enough below the surface to be out of sight, and out of the reach of the absorbent powers of grass roots, while even when ventilated they do not give access to a sufficient quantity of air in contact with the decaying mass of organic matter to insure its decomposition. The soil close about them soon becomes saturated with a vile compound, filling its pores by degrees, and finally refusing to carry off even the water, except during the dryest part of the year. Such contamination of the soil in the neighborhood of dwelling houses is, under all circumstances, to be avoided. Cesspools should therefore be made tight by brick floors and walls, laid in hydraulic cement and plastered with as much care as if they were to act as rainwater cisterns. What then is to be done with their contents when filled? The best way in theory, doubtless, is to use it for fertilizing the soil. This may be done by pumping and carting where there is not enough land near the house suitable for its absorption. It can be distributed on the land by gravity where there happens to be land low enough, though small house lots seldom give this opportunity. In accomplishing this where there is land adapted to the purpose, an *intermittent* flow is desirable, both for the sake of flushing the pipes and avoiding deposits within them, and to allow the air an opportunity to follow the sewage as it soaks down into the pores of the soil. The air, thus admitted alternately with the fluids in the finely-divided pores, serves to oxidize a large portion of the organic matter—to burn it up, as it were, and form such new compounds as to favor its more ready appropriation by vegetable life. This intermittent flow has been attained with some degree of success by Field's flush tank. So far as its flushing power goes it leaves little to be desired, but it is doubtful whether there is time enough left between its periodic discharges, ordinarily, to allow of much oxidation in the pores of the soil; for this process is a slow one, and must necessarily require a good deal of time where the quantity of sewage is considerable.

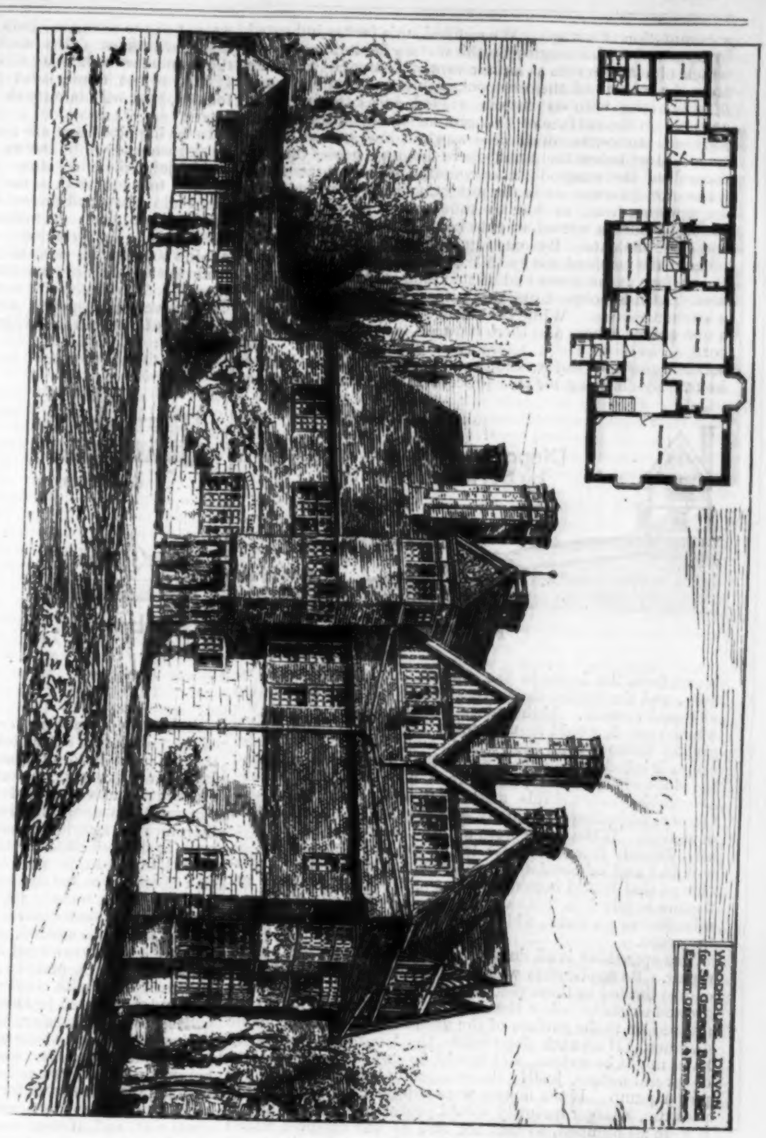
Mr. Rogers Field has introduced this process in England, and Col. Geo. E. Waring, Jr., has introduced it in this country and applied it for this purpose with some success. He distributes the sewage from the flush-tank below the surface, in porous drain-pipes with loose joints laid less than twelve inches under the surface. The end sought is to fill the whole system of these pipes with each discharge from the tank, and the sewage is to soak away from the joints of the pipes while the tank is being refilled. In some places this plan has worked well, while in others the joints of the pipe or the pores of the soil, or both, have apparently become choked with the solid particles held in suspension by the sewage, to such a degree that the absorbing power of the soil around the pipes has become impaired. The result is that the sewage bursts up to the surface and becomes a nuisance near the lower end of the system of distributing pipes. This fault can perhaps be remedied or avoided by a thorough underdraining of the soil and by taking proper pains in laying the drains and providing sufficient surface of land for absorbing a given amount of the sewage. Different localities and different soils give very different results, and it becomes very largely a question of judgment in matters of detail, to adjust the parts of this system so that it will work without further annoyance. It seems to be yet a matter of doubt, however, whether the distributing drains will remain *permanently* porous in any particular case where the quantity of sewage is considerable. The weak point in the system seems to be that certain portions of the pipes and the surrounding soil become so lined with the solid particles of the sewage that the pores are closed by degrees. This capacity for continued absorption will, however, depend very much on the physical character of the soil and the perfection of its under-drainage. The water must, of course, be given a free path to escape from below the pipes that distribute the sewage, either by selecting a locality with a subsoil that is always dry and loose, or by rendering it so by deep drainage. A perfect uniformity of condition in the porosity of the soil throughout the whole system of distributing-pipes is hardly possible to be attained. It follows that when the less porous places begin to clog, a larger duty is imposed upon the remaining portion, till sometimes the greater part seems to become obstructed. The only remedy is to dig out the pipes and clean them, and the frequency of this operation can only be determined by actual trial.

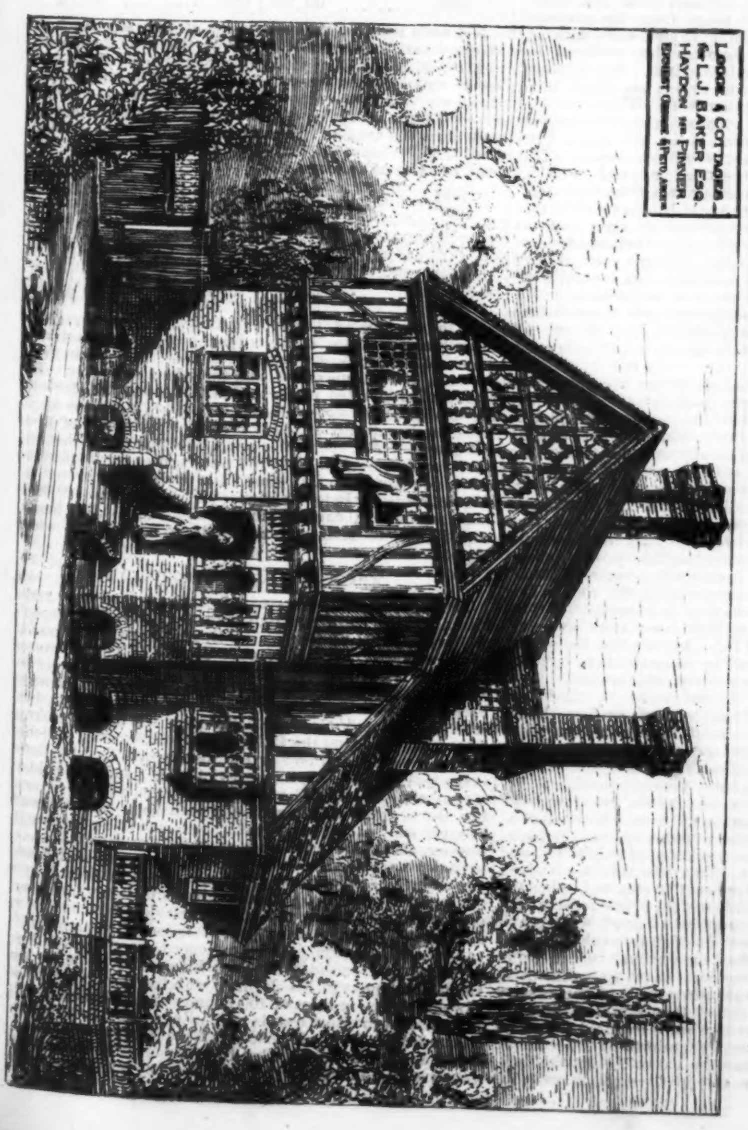
In all cases where a distribution of sewage is made on the surface or underground, a thorough under-drainage is absolutely necessary. Any locality where this cannot be attained within reasonable limits as to cost is therefore quite unfit for this method.

Distribution of the sewage on the surface, though requiring more attention at stated times than the method just described, is sometimes made use of with success, even on the small scale of one or more houses. I have myself a house occupied for three or four months of the hottest part of the year, managed thus. (See Fig. 5, page 3854.) A tight cesspool is made in the ground, about one hundred feet from the house, of a capacity sufficient to hold about one week's

* From a lecture by Mr. Edward S. Philbrick, C.E., delivered before the students of the Massachusetts Institute of Technology.




WOODHOUSE, DEVON.


LODGE & COTTAGES
for L.J. BAKER ESQ.
PINNER.

accumulation of sewage. When filled, this fact is indicated by an overflow discharging on the surface behind the stable, which pipe also serves as an air vent. A trench was dug from the bottom of the cesspool, about one hundred and fifty feet long, with its bottom graded so as to drain the cesspool on the surface of the ground in this distance. A four-inch stone-ware drain pipe was laid and buried in this trench. Just below the point where this pipe passes through the wall of the cesspool, a common four-inch brass-faced water stop-gate was set in the pipe, C, with a four-inch pipe set upright from its top to the surface of the ground, through which a wrench or gate key can be inserted, to open and close the gate. By opening the gate, the whole contents of the cesspool are by this means discharged at will on the surface at the lower end of this pipe in five to ten minutes. At this point of discharge lies a plat of land used as a kitchen garden. While the sewage is flowing, a man with a hoe guides it there and there between the rows of peas and corn, so as to secure a tolerably uniform irrigation. The soil is light and sandy, and absorbs the whole in half an hour. By choosing for this process a time when the wind

FIG. 5

blows from the house to the garden, no inconvenience results, and the garden shows the benefit of this application of liquid manure. If this place were to be used during the whole year, it would require more breadth of land and a greater distance from the house to avoid offense. But under the existing circumstances, where the character of soil and the slope of the surface, and direction of prevailing winds, all combine to favor this method, it has proved very satisfactory, and might be equally so if applied to a combination of houses. If the drain were allowed to discharge continually, directly from the house to the garden, it would flow as a driblet and accumulate a mass of filth at the point of discharge that would become a nuisance. The amount of attention required in this case is trifling, being only about ten minutes once a week, which is well repaid by the benefit to the crops.

The apparatus is all durable, and not likely to get out of repair. Its application without the labor of pumping is of course limited to those places where a sufficient slope of the ground exists to allow the bottom of the cesspool to be drained on to the surface of the ground within a reasonable distance. If no such slope exists, the labor of pumping by hand might be serious, and would, in case of a combination of several houses, justify the erection of a windmill or horse power pump. If the houses were supplied by water under pressure, a larger quantity would probably be used than if it were all pumped, so that the size of the cesspool would either be increased, or the periods of emptying be made more frequent, all of which items must vary considerably with local circumstances and the wants of the families concerned.

Whenever cesspools of any kind are used, especial care must be taken to break the continuity of the drain between them and the house. The most efficient way to accomplish this in a climate where the winters are as severe as with us, is to have a running trap in the drain, of similar section with the drain itself, round and smooth, and to open the drain to the air on the side of the trap toward the house. (See Fig. 6.) As it is desirable to have this trap accessible,

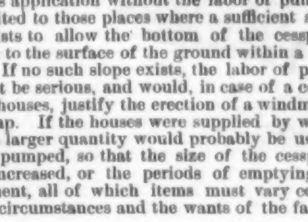


FIG. 6.

it is usually walled around up to the surface with a cover like that of a coal scuttle at the top. In order to admit the air freely this cover should be perforated with holes. When sewers are provided, some writers on the subject favor the omission of this trap on the main drain, on the ground that it obstructs the continuous flow of the sewage, and that the air of sewers, when properly constructed and ventilated, is not likely to be so bad as that of the house drains. But I prefer the outside air to either, and do not regard the slight delay of drainage in passing through this one trap as of much consequence. If it is so constructed as to have no square corners for accumulation of deposits, and if all the drainage of the house flows through it, nothing can stay there long. But this trap should never be applied without the air hole as described above.

The material generally used for drains outside the house walls is glazed stoneware. It is a good material for the purpose when well made. It is furnished in lengths of two or three feet, with special forms for branches and bends. The defects to be avoided in using it are chiefly distorted forms, easily detected by the eye. It should be put together with hydraulic cement, care being taken to keep the joints concentric. Some people recommend hemp gaskets, to be used to hold the adjacent pieces concentric; but unless more length of socket is provided than in the forms now made, there is not much to be gained by using the gasket. Care should be taken to provide a continuous support for the pipe between the sockets by bedding it in cement for the whole length, unless good packing gravel is at hand which can be rammed in on either side. If this is not done, the weight of the filling is likely to break the pipe, particularly the smaller sizes. Care should also be taken to wipe out the surplus cement that is likely to project on the inside, If this is not done, solid rings of cement will be thus formed, that will dam up the sewage and entirely stop the pipe.

In laying pipes that are too small to allow a man's arm to work inside, say nine inches and smaller, this wiping the inside joint must be done with a swab held by a ratan, about a foot longer than the joint of pipe, kept in the last piece laid down and drawn through every joint after the cement is applied. In making connections between drains all rectangular junctions called T-branches should be avoided, except on vertical lines. The joints known as Y-branches are the only ones fit to be used on horizontal lines. (See Fig. 7.) The use of rectangular connections is sure to be followed by deposits, through the eddy caused by the conflict of currents, as explained in the case of sewers.

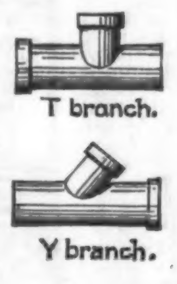


FIG. 7.

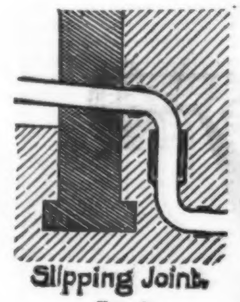


FIG. 8.

A most important matter in laying drains is the character of the foundation on which they are laid. If upon filled land, it is liable to settlement, and since the stoneware pipe, jointed with cement, is perfectly rigid, the least settlement breaks it somewhere, and leakage occurs. The buildings generally rest upon piles in such places, and the drain being therefore on a rigid foundation where it leaves the house wall, is sheared off near this point by the settling of the material outside the wall in which it rests. The substitution of iron pipe for the stoneware between the house and sewer does not remedy the trouble, for even iron would be broken under such circumstances. Where there is a foot or two of fall to be spared, the trouble may be remedied by making a step downward in the drain just outside the house walls (see Fig. 8), making a vertical joint with a long lap and packing it with elastic cement; but this extra fall can hardly be provided in Boston upon the filled lands, without getting below tidewater, at least not until the new system of drainage shall come into use, through the intercepting sewer now in progress. The weak point being just outside of the house walls, can generally be made accessible in the same man hole which serves for access to the main trap and air hole; so that breakage can be detected and repaired without great cost, and, if inspected frequently, without incurring the risk of saturating the soil with filth in contact with the the cellar walls, as is often done by such leakage. I have seen it in some cases penetrating through stone foundation walls and up through concreted floors from the saturated soil outside. It is next to impossible to shut such filth out of the cellars after the soil once becomes thus polluted, for it is both fluid and gaseous, and penetrates the minutest pores. Even where the soil is firm, drains are often found to be broken just outside the cellar walls if they are laid above the bottom of the cellar excavation, as is sometimes done, owing to the loose condition of the soil that is filled under them at this point, where recently excavated. This can be corrected by puddling the filled material under the drain by water, and waiting a week or two after such puddling before laying the drain. It should be remembered that drains when once laid and buried are out of sight and out of mind. A slight defect through poor workmanship can only be detected after some months, perhaps years, during which time soil may have got polluted to an incurable degree. It therefore becomes of the first importance to see that the drains are laid in a permanent and workmanlike manner at first, otherwise the pollution may go on till the house is rendered untenable, which would otherwise have been healthful.

The size and inclination of house drains are important matters, to be settled by proper principles. Where but little rain water is to be provided for, a four-inch pipe is large enough for any ordinary house drain, whether outside or inside the walls. But it is generally desirable to take into the drain the rain water from at least one half the house roof, for the sake of flushing the outside trap. Moreover, the stoneware pipe when as small as four inches in diameter is too imperfect in shape to make a continuous smooth conduit, without slight offsets at the joints that interfere with the flow. So it is generally conceded that private houses should have at least six-inch drains when made of stoneware and receiving some rain water from the roof. This size is large enough for the sewage of a household of fifty persons or more, unless the rainfall from more extended roof surfaces is to be provided for. In this case the size of the drain is to be governed, first, by its inclination, which is generally limited by local topography, and, second, by the size of the roof to be drained. In our climate, a rainfall of one inch and a half per hour from the roof surface should be provided for, adjusting the size of the drain to carry this rainfall. In such cases the sewage can be practically ignored, for its volume is insignificant in comparison with the rain water. The problem becomes then a question in hydraulics, and reference must be had to the governing elements and well-known physical laws, from which we compute the required size. In order to make drains self-cleansing, their contents should have a velocity of at least two and a half or three feet per second. To attain this in a six-inch pipe a slope of one and a half per cent. is required, when the drain is running half full, and it seldom is filled above that point. If this rate of slope cannot be attained, some provision must be made for frequent flushing to avoid deposits, for it must not be forgotten that the cardinal rule in drainage is to *keep everything moving*, and allow no sediment to remain in the pipes: Drains are often made of unnecessary size. This is a more serious defect than would at first appear, for increase of size beyond what is required for carrying capacity is an actual injury, by diminishing the scouring power of the current. It cannot be expected that the interior of our drains and sewers should be so clean as to be entirely free of the gases of decomposing matter, but it is very desirable to reduce their volume to a minimum, and then apply all possible precautions to prevent their mixing with the air we breathe.

The large increase of the quantity of water used in our houses at the present day, compared with that used by former generations, is justly regarded as a most valuable agent for raising the standard of cleanliness among the poor and for contributing to the comfort and luxury of the wealthier classes. But it must not be forgotten that the use of water in this way brings with it an increase of risk if not properly got rid of. The more water we use to dilute our sewage, the further it will penetrate through the pores of the soil, unless securely led off in proper channels, to proper places.

AMERICAN SILK MANUFACTURE.

IN 1810 Rodney and Horatio Hanks started the first silk mill in America, in the town of Mansfield, Conn., for the making of sewing silk and twist. It was not a pretentious affair, being only twelve feet square, and its machinery was doubtless rather crude, for the proprietors made it themselves, according to their ideas of the adaptability of means to ends. With varying fortunes the Hanks family stuck to the enterprise for several years, but finally gave it up. Then Wm. H. Horstmann, of Cassel, Germany, in 1815, established in Philadelphia a manufactory of trimmings, wholly or partly silk, to which were subsequently added ribbons, plaited and braided goods, fringes, sashes, etc. As early as 1824 he introduced in his works the Jacquard loom, and thirteen years later power looms invented by his son, Wm. J. Horstmann. That old concern is still in existence, has the largest mills in the country engaged in its especial line of work, and stands at the head of the long list of manufacturers now engaged in the production of its class of goods. In 1827-8 the Mansfield (Conn.) Silk Company started a mill, but, through an erroneous idea that they could profitably raise their own cocoons instead of importing the raw silk, failed, in 1839, after the expenditure of a large capital, but with the satisfaction to those concerned of having practically demonstrated that silk manufacture here could be successfully prosecuted, if unhampered by unwise attempts at silk culture. It does not seem necessary or even desirable to recount, in this connection, the very long list of silk manufacturing enterprizes that then sprang up here and there over the country, and with varying fortunes—generally rather adverse, however—kept the industry alive and gradually growing. Some of those enterprises are still flourishing, and have, in these later years of prosperity, grown strong and great. Many more failed early, but the failures did not deter, but on the contrary, rather seemed to excite to emulation other sanguine experimenters. As almost the entire amount of raw silk used by these factories was imported, owing to the impossibility of getting American silk properly reeled, the importations of that crude material might well be taken as at least an approximate indication of the vicissitudes of silk manufacture in its earlier years in this country, due allowance being made for other influences affecting importation. Reviewing these, we find that the dutiable imports in different years varied thus:

1824............	$1,254	1830............	$119,074
1825............	8,090	1831............	134,376
1826............	192,496	1832............	48,938
1827............	135,230	1833............	135,348
1828............	608,738	1834............	139,256
1829............	101,796	1835............	10,715

Not until 1853 did the importation of raw silk reach the extraordinary amount of 1828, but in that year it amounted to $712,092, and in the succeeding year (1854) to $1,085,261, and in only one year since (1862) did it fall below, amounting to only $489,516. In 1858 the duty was taken off raw silk—with the exception of ten per cent. levied on that imported via the Cape of Good Hope, which was maintained until 1866. From that time the imports of raw silk have been in value as follows:

1866....	$3,437,900	1873...........	$6,460,621
1867...........	2,469,001	1874...........	3,854,006
1868...........	2,520,404	1875...........	4,504,306
1869...........	3,318,496	1876...........	5,600,877
1870...........	3,017,958	1877...........	5,591,084
1871...........	5,739,592	1878......	6,807,725
1872...........	5,625,620	1879...........	9,921,032

At the close of 1873 there were only 156 firms engaged in the silk manufacture, in all its branches, in the country, of which 30 were in New Jersey, 61 in New York, 25 in Pennsylvania, 22 in Connecticut, and the others scattering. The total capital invested in the industry was only $15,988,877; the total products were valued at $19,894,874, and the operatives numbered only 10,651. In 1876 the number of firms had grown to 213, the hands employed to 20,000, the products to $27,000,000. By 1879 the figures given for the whole country six years before little more than covered the silk interests of Paterson alone, which then had 102 firms and corporations engaged in it, employing 12,599 hands, with $9,955,500 invested, and produced $12,172,995 worth of goods that year.

WHERE RAW SILK IS PRODUCED.

The raw silk as it comes to this country is of very variable quality. That from Italy and France is best, Japan's product and that of Broussa (or Brutia) is nearly or quite as good, and that from China is poorest. The difference amounts to as much as $2 per pound, and that simply because of the greater care employed in reeling the Italian and French products from the cocoons. The Japanese produce some exceedingly fine raw silk, quite worthy of ranking among the best, and the Chinese are fully capable of doing so, but are either too lazy or too dishonest. That the latter is the real reason is the firm conviction of some of the oldest manufacturers. They have found that where the Chinese can do so they will ingeniously load their raw silk with foreign substances—rice, sugar, etc., to make it weigh heavier, and that even when they know the deception must invitably be detected, and will lose them good and steady customers. The only way to put a check on them is by a concerted action among American manufacturers to shut out of this market all their raw silk, which does not come up to a certain standard, and that is now talked of in the American Silk Association. An experienced manufacturer here says that "all considerations are inoperative to make the Chinaman honest in his dealings with the foreigner." The raw silk comes in bales of 100 pounds, or picul bales of 133⅓ pounds, and in either case is primarily in skeins, secondarily in bundles of from eight to twenty-five pounds each, and, lastly, in the big bales. That from some parts of China and Japan is of a lustrous light golden color, but much more

from China and the general supply from Broussa and Europe is of a snowy white. In this condition it feels hard, owing to the glaze of the natural gum that is still on it, and one of the earliest processes through which it must pass is the removal of this material, by which it loses about twenty-five per cent. of its weight. If the Chinaman has been at it with his cunning devices, the necessary loss will be still greater, and the "throwster"—as he is termed who prepares these filaments for weaving or working—will have to suffer a loss beyond the recognized allowance for that diminution. Formerly it was the custom here, as it still is in some parts of Europe, for the throwster's establishment to be as independent of all the other processes of silk manufacture as the dyer still is to a great degree even in this country. All the processes of cleaning, winding, doubling, twisting, sorting, rewinding, and reeling, according to the various uses for which the completed thread was intended, belonged to him and were contracted for by the weaver or dealer in finished silk threads. Now, however, the larger silk manufacturing establishments in this country do all their own "throwing." That word, by the way, is said to be derived from the old Saxon thrawan, to twist.

SILK MANUFACTURE.

In order to arrive at as clear an understanding of the multifarious processes of silk manufacture as may be conveyed in the narrow limits of a newspaper article, the works of two representative factories, one dealing with the raw silk and the other utilizing a very different material, will best illustrate how the main products of popular use in silk goods are attained. The first is the extensive mill of the Phœnix Manufacturing Company (formerly B. B. Tilt & Son) in Paterson, N. J., where in the busy season 1,000 hands are employed, and where, even in the present dull time, between seasons, 900 are at work. This mill, like nearly all the old silk works in the country, has grown by accretion, by additions of building to building to meet the requirements of business, so that to say it rambles is stating the fact mildly, especially after one has endeavored to pursue the raw silk through its various scattered divisions. But throughout it all are two charms that belong exclusively to a silk mill—cleanliness and pure atmosphere. Cotton and woollen mills are foul and noisome places by comparison with it. The raw silk, when first received, is carried to the sorting room, where the different degrees of fineness regulate its assortment by deft fingered girls into separate piles. Then a parcel of skeins of uniform grade of thread—if the lightly twisted filaments from the cocoons can so be called—is inclosed in a light cotton bag, and soaked in water at about the temperature of 110° Fahr. for a few hours, for the purpose of softening the gum, and facilitating the process of winding. When taken out of the water these bags are put in an open cylinder, porous on the sides, and set in a machine which is operated by steam power and causes the cylinder to revolve with great velocity. In five or ten minutes the water is pressed out, and the gum sufficiently softened to permit of easy winding. It is then wound first on a spool about 3½ inches in length. If it is Chinese silk, it is cleaned by being passed through the cleaning machine, each thread usually, but not always, passing between two sharp-edged metal plates, which remove any unevenness, leaving the filament smooth, clean, and even. The Italian silk does not usually require this cleaning. The silk on the second spool is next passed to a doubling machine, where two or more threads are joined together and drawn upon a third spool. The silk in this state is put in the spinning machine and spun a certain number of turns per inch, more loosely, if intended for "tram"—which makes the "woof" or "filling"—than if meant for "organzine," which is the warp. In common parlance the words warp and organzine are used indiscriminately, but this is incorrect. When two of these threads are doubled together and spun upon a fourth spool, the twist being reversed to make the thread stronger, the resultant thread is organzine, whether it ever becomes warp or not. The number of threads joined for tram depends upon the fineness of the raw silk, and also upon the character of the goods to be woven; belt ribbons for instance, requiring a coarser shot thread than bonnet ribbons, and some sashes and silk dress goods requiring heavier filling than others. Where it is intended to make sewing silk, or twist, four, five, or six, or even ten threads are joined together. That, however, is not done in this mill, so can only be incidentally mentioned here. When the silk is thus brought into the condition of thrown silk, tram, or organzine, it is usually transferred to a reel, and made up into skeins preparatory to being dyed of the desired color. The dyeing of the thread of this mill is done by outside parties, as is the case with a number of the best Paterson mills, the manufacturers deeming it best to confide that very delicate and highly responsible process to parties who make a specialty of it, and have at their command greater facilities for it than could readily be obtained in an overcrowded establishment. It is practicable for the dyer to load the thread with two, three, or even six times its weight of chemicals, filling the interstices between the fibers and the filaments themselves with dyestuffs which make the thread seem more solid, thick, and stronger than it would naturally be, and this is a common practice in Europe; but such silks rapidly grow thin in wearing, crack, fray, and get a greasy look. Nothing of the sort is done to the goods of this mill, or indeed, of any reputable American silk manufacturer, and it is to this fact above everything else, this high credit of absolute honesty, that American silk goods owe their present excellent reputation all over the world. Further mention of this matter will necessarily be made in another connection, and here it need only be reverted to. Leaving out of the question dyeing, which may or may not be required, before it becomes organzine, raw silk must pass through the successive processes of assorting, winding, cleaning, spinning, doubling, twisting, drachming, winding, cleaning, doubling, warping and picking. For tram it must go through assorting, winding, cleaning, doubling, spinning, drachming, winding, cleaning, doubling, and quilling. The dyeing comes after the seventh process mentioned for organzine and the sixth for tram. The drachming is a delicate process of weighing the silk, skein by skein, and according to its grade or rather the thickness of its thread, which is thus determined, dividing it off into as many as nine separate lots. To the inexperienced eye and touch they all seem alike, but this nice discrimination is absolutely necessary to secure that perfect evenness on which the success of manufacture depends.

THE JACQUARD LOOM.

The tram silk is wound on quills for the shuttles; the organzine, run from the spools on a warping mill, a great upright, revolving cylinder five or six feet in diameter; and finally, after every thread has been carefully picked over, is rolled on the weaver's beam. Tedious and long have been the processes by which the slender filaments have been brought to their present stage of preparation, and there is still one job to be gone through with that looks as if it would make a nervous man wild, and that is the leading of the threads of the warp, one by one, each through its individual slot in the reeds of the swinging bar and loop in the harness. There are thousands of those threads, and an error in the placing of one would play the mischief with the whole business. Anybody who can find real enjoyment in straightening out a fish line tangled by an active eel might like this sort of work, but few surely possess such Job-like patience. After this, however, the reward of realization of the perfect artistic work, toward which all preceding has been but gradual advancement, is to be enjoyed.

Beneath the rackety clatter and bang of the three hundred power-looms in constant operation, forms rich in beauty of design and brilliant in the glory of color are momentarily growing into being as the swiftly flying shuttles carry their wealth of glowing tints through the ever-changing intricacies of the shifting warp. If there is any machine that the prophet might have added—had he known anything about it—to "the way of the wind," "the way of a serpent on a rock," and other things noteworthily hard to find out, it would doubtless be the Jacquard loom. Why irregularly punched holes in a seemingly endless succession of card boards should result in developing the most wondrously intricate patterns on the fabric growing into being below is a puzzle that few persons outside the fraternity of weavers can honestly say that they comprehend. And yet, as Mr. Thorp, the superintendent, here explains it, it seems simple enough for the moment. Each card represents one thread of the filling. A thousand ends of wires, more or less, press against each card as the machinery brings it in turn to its place where the holes are, the wires go through by pressure of a spring at their other ends; and so a hook connected with each wire is allowed to come forward far enough to be caught by a rising blade of steel, and that pulls on certain strings connected with the lower ends of the wires, which in turn lift up selected threads of the warp and make at each moment new paths for the shuttles to travel through. The wires that have no holes to get through, of course, cannot bring their hooks forward far enough to catch the lifting bars, and the threads of the warp which they affect remain down until next time or some other.

To complete a pattern sometimes requires as many as ten thousand cards, all strung together by their edges, like a "Jacob's ladder," going flippety-flop after each other up to the head of the loom and down again. Ordinary portraits woven in ribbon silk require from 1,500 to 4,500 cards, and fine pieces of badge work, such as the Cardinal McCloskey bookmark, or the splendid one gotten out at the latest Paris Exhibition by the firm, about 6,000.

The weavers of Lyons used to hold pre-eminence over the rest of the world for their Jacquard loom productions, but their best work has been outdone by this establishment, and by comparison with some of the designs woven here, the most pretentious English works look like bad caricatures. The pictures or other designs which are to be woven are first drawn by Messrs. Alcock and Wood in the size they are to appear, then enlarged to scale upon paper ruled to minute squares, and finally the holes are punched in the cards in correspondence with the marked squares on the enlarged design. A great deal of secrecy is observed in this department, to prevent rival manufacturers finding out what is going to be done in the way of new designs.

The intricacy of the Jacquard loom—and really it does look like a terrible thing as one views its enormous sheaf of twitching strings, and thousand rattling wires, and five thousand wriggling cards—is still further increased by an attachment down below, in some of the power looms, by which they throw, as required, four different shuttles, bearing threads of various colors; but that cannot be explained without diagrams.

Other looms there are, appropriately called gang looms, one of which will weave as many as twenty-four ribbons at once, that will have inwoven beautiful flowers, gay-plumaged birds, curious Oriental designs, and other blossomings of the designer's fertile fancy. A great many of the men employed in this mill are from Macclesfield, England, and it has been common to call the latest arrivals among them "sparrows." There are fewer "sparrows" than there used to be, by the way, for some of the latest arrivals, horrified by that very hot spell of weather in early May, wheeled around and fled back to England. But, before they left, the idea occurred to one of the artists to get up a "sparrow" design for some figured dress goods, and it has proved so popular with dealers that a large number of looms are working on the reproduction, in various colors and different fabrics of that pretty pattern. The success of this design illustrates an advantage which our manufacturers enjoy, and it is not an unimportant one, in the readiness with which they can meet a demand for any new thing they may get out which strikes the popular fancy, instead of being subject to the inevitable long waiting, possibly until the whim of fashion had changed, which the European silk weaver would have to dread in catering to the market of this country.

From the looms the woven goods go through certain finishing processes of smoothing, searching for imperfections, measuring and folding, after which they are ready for the market with the exceptions of the ribbons, which are first wound on blocks, and the handkerchiefs, which are cut apart, hemmed, and boxed in assorted lots. The handkerchiefs are much more beautiful and more durable than any imported, but are not large.

The manufacturers say that the market demands a small silk handkerchief, and does not want a large one. The products of this mill include figured satins, gros grains, grenadines, and other dress goods, scarfs, handkerchiefs, figured ribbons of every description, book marks, badges, etc., in endless variety. Seventy hand looms are still kept in operation by the Phœnix Manufacturing Company on the heaviest and finest classes of goods. Experience has demonstrated that while the power loom may closely simulate, in its rapid automatic action, all the processes of the old hand loom, it cannot supply the place of the careful hand-weaver's watch for imperfections, and instant remedying of them.

In the weaving department of the mill about two-thirds of the employes are men and one-third women. In the throwing department the proportions are reversed. Wherever men and women do the same work, they receive equal pay. The average wages of a throwster or weaver is $1.50 per diem. The weaver earns more while his work is actually in operation, but his loss of time in waiting for beams, arranging the loom, etc., brings his earnings down to about that amount.

Formerly there was a great deal of private weaving in and near Paterson. Almost every skilled weaver who came over from England brought with him his loom, and it was customary to give out beams ready set with warp, adequate supplies of filling, and the pattern cards where figured weaving was to be done. But in time manufacturers found that this system practically put them at the mercy of the independent private workmen. A man might finish his web of one hundred and fifty yards in two or three weeks, and might delay over it as many months when the goods were most needed. He might get intoxicated and spoil it altogether, and he might, if dishonestly disposed, steal a duplicate of the cards of a particularly beautiful and valuable pattern and reproduce it for some other manufacturer. So, gradually, the greater part of the weaving was concentrated in the mills, where it can be done under the best and most economical conditions, and there are now hardly more than two hundred private looms, it is estimated, in Paterson. In some other parts of the country, however, the old practice still is kept up by small manufacturers to a considerable extent.

SPUN SILK.

The second representative mill to which reference has been made, that of Cheney Bros., is in South Manchester, Conn., with a branch for ribbon weaving in Hartford. The processes employed at the main establishment are widely different from those which have been reviewed, so much so as almost to deserve to be classed as a separate industry; for here the starting point is not the raw silk reeled from the cocoons, but the cocoons themselves. This is known as the manufacture of spun silk, and the Cheney Bros. not only practically monopolize it in this country, but have brought it to such perfection that their goods excel any others of like class made in Europe.

There is a larger silk factory in England devoted entirely to the making of thread and twist from spun silk, but this establishment of the Cheney Bros. is the largest in the world for the production of woven fabrics from spun silk entirely or its admixtures with "thrown" silk.

There are certain cocoons from which the filaments cannot be unwound, such as doubles, in which two worms have enshrouded themselves together, crossing and entangling their threads beyond hope of straightening out by the most patient reelers, and these sometimes amount to as much as ten per cent. of the product of a cocoonery. Then there are others which have been pierced by the insect, exuding a fluid which softens one end of its encasement and enables it to push its way out, and these, too, are unfit for reeling. Then there is a great deal of "frisons" or "filature waste," the tangled floss from the outside of the cocoons, and the waste made in unwinding them. Last of all, there is a limited quantity of raw silk more or less broken and tangled in the earlier operations of the silk mill, and known as "mill waste." All this is excellent material, pure silk, capable of manufacture into fabrics which are equally as durable as those from the raw silk, and in their finer grades almost as beautiful, lacking only a little of the luster belonging to the reeled silk products. But to utilize this material requires costly machinery, specially adapted for the purpose, and an infinite deal of care and labor.

To begin at the beginning: The cocoons come in vast bales from China, Japan, Asia, India, Turkey, France, Italy, and Spain, and are worth, according to quality and other conditions of value, from 10 cents up to $1.50 per pound. The best are in the form known as Mawata, prepared in Japan, which presents the material no longer in the crude cocoon shape, but as a wad or tuft, like silken "batting," each wad weighing about a quarter of an ounce and containing the silk of probably a dozen cocoons, which have been soaked in hot water, freed from the dead chrysalis inclosed, and spread out so as to part their filaments.

The first process with all the cocoons is to bring them to the mawata condition. To do this they are soaked in hot water, to which a certain proportion of alkali has been added. This softens the gum and loosens the filaments. Then the dead chrysalis—if double cocoons are under treatment—is extracted, and the fibers are pulled apart sufficiently to admit of thorough and comparative easy disentanglement by the machinery. After being well washed and dried, the material is next carded by huge machines bearing a distant resemblance to cotton or wool carding apparatus, but much larger and with stronger parts suited to the greater strength of the fiber to be treated. The carded mass of straightened filaments, as it passes around the great drum of the machine, is cut off in lengths of about eight inches, and these are successively by skillful hands, taken off between boards which keep the filaments straight, and in that condition are known as "books."

In another machine these "books" are placed one by one, and the glossy fibers are combed by machinery, after which the now thoroughly disentangled and orderly arranged mass of filaments from each book is carefully rolled together in a bunch weighing only a fractional part of an ounce, and carried to the department in which its first approximation to the thread form is made. These bunches are spread out evenly on a belt which forms an endless table, and are carried forward to another belt running at right angles with it in such manner that successive portions of the filaments are laid partly on those placed before, as shingles are laid upon the roof of a house, and in this condition are passed through machinery, which forms them into a loosely pressed, soft, lustrous band. This band is by other machinery drawn out, doubled, twisted, drawn out again, again doubled, and so on, until it finally takes the form of any desired thickness, according as it is intended for tram, organzine, sewing silk, or twist. From the time it assumes the soft band form the processes through which it passes are so closely akin, generally, to those of cotton spinning that detailed description of them is needless. There is, however, much greater delicacy in the machinery and much more care exercised in its manipulation in the spinning of silk, the attainment of a thread devoid of projecting fibers and of absolute smoothness being the end constantly in view. To this end, in one stage of its progress the silk thread is made to pass at great speed over a succession of whirling spindles, which polish off many of its roughnesses, and then it runs through the flame of a gas jet, which burns off any loose ends of fibers, but cannot harm the swiftly moving body of the thread itself.

The lowest grade of spun silk thread produced by all this labor is worth $4 per pound, and the highest $8, which is far below what thrown silk commands, and consequently enables the manufacturer to make an excellent quality of pure silk goods at very low prices. As an indication of what a vast deal of machinery is required for this spun silk factory, it is worthy of mention that it has exhausted the capacity of a 400-horse power engine, and that another of equal force is about to be added, while the mill itself occupies four buildings, each 50 feet by 250 feet, and three stories in height. From this mill the thread is transferred to another—the old factory—stationed a little distance away, where all the processes of dyeing, weaving, printing, and finishing are carried

on. In regard to the weaving, there is little to say about it other than has already been said of the similar department in the Phœnix mill, except that here there are only about a hundred Jacquard looms and four hundred plain wide and gang looms, the products of this mill being, to a large extent, serges, gauzes, handkerchiefs, brochés, mummy cloth ribbons, and stuff suitable for printing. Exquisite novelties in figured goods for milliners' uses are, however, turned out from these looms, among others of the present season, embossed silks, satin, corduroy, and printed satins in almost endless variety. The printing is done by a huge press, akin to a calico printing machine, which gives off its color from engraved copper cylinders, and is capable of printing five colors at once with great rapidity and accuracy of register. The colors thus put on are set by exposure to steam in a close chamber, and are as durable as those imparted by dyes. One novel feature in this printing work is the impression on a colored web of a chemical which takes on the ground color wherever it touches, a process which is called "discharging color." In the finishing the goods are calendered by passing overheated steel cylinders, under great pressure, and the heavy fabrics of the finer class, such as brocades, are made to run over gas jet flames, which burn off any fibers that may break the evenness of the surface without in the least injuring the web. There are some goods that have to go through the rolls at an exceedingly light pressure, others that require a squeeze of 60,000 pounds; some that must be pressed hot and others cold. Different surfaces on the rolls may convert plain siks into striped ones or change them to moiré antique. Brocades and fancy silks as well as plain goods must go through the process, and the effect in bringing out the beauty of figured goods is sometimes very remarkable. Satin requires an enormous pressure to bring out the full luster which constitutes its beauty.

The processes of dyeing, formerly a great mystery, are now, since the introduction of aniline colors, exceedingly simple. As a rule the color is imparted to the thread in skeins, but some classes of fabrics are dyed in the web. Purity of dye and absence of the factitious weighting, which too generally disgraces European silks, are among the prominent characteristics which, with the added qualities of strength and durability, have given an enviable reputation to the goods produced by this mill. Notwithstanding the fact that their better fabrics are either wholly of spun silk or filled with that material on a reeled silk warp, the excellence of their manufacture is such that it is not easy even for experts to detect them from others woven wholly from reeled silk, yet their price is, on an average, only about half as great. The Cheney mills employ 1,500 hands, even between seasons, and last year turned out goods to the value of $2,250,000.

THE EXTENT OF THE INDUSTRY.

Among the more than two hundred silk manufactories in this country, there are many branches of the industry which are necessarily passed over without such detailed description as has here been given to the leading ones likely to invite most popular interest. One of these is the making of sewing silk and machine twist, which was among the first started on this continent. At present our silk mills turn out thread and twist, which are generally recognized even in Europe as of superior quality, strong, and free from false weight of added chemicals in the dyeing. Still another and exceedingly interesting branch of the industry is the weaving of silk lace. For this all thicknesses of thread are employed, from "singles"—which are merely doubled cocoon threads—up to substantial silk yarns, and the most elaborate kinds of hand-made lace are so perfectly counterfeited that it is almost impossible to detect the work of the loom. Lace making machines are large, costly, and too intricate for description. They resemble no other mechanism, and to understand them even seems hopeless to the casual visitor. But their products are astounding. In a case in court last year some laces were exhibited over which three experts differed. One pronounced them hand-made, of European production; a second affirmed that they were the finest Calais machine-made; the third hit upon the truth, that they were made in this country by machinery, and their manufacturer, who was present in the court room, identified the goods as of his making. Yet a third silk industry is the making of trimmings, military goods, fringes, etc., which employs many thousand hands, and is of itself so wide a field that any attempt to go over its infinite varieties in this connection would be futile.

Silk manufacturers declare that the great reason for their success, in the past few years, has been the high tariff on imported silk manufactures, which has practically equalized the cost of labor. At the same time there are other considerations which do not deserve to be overlooked in estimating the causes of their present flourishing condition. Primarily, they have dealt with their customers according to the strictest laws of honesty. They have not weighted down their silks with fraudulent and injurious chemicals, as European manufacturers have. They have purchased only the best obtainable raw silks, and in using spun silks have been so perfect and ingenious in their processes as to surpass European competition. They have developed a fertility and taste of design and a skill in execution which are nowhere excelled. (The Grimshaw Bros., of Paterson, for instance, produce handkerchiefs which far excel in beauty any of European manufacture, as is frankly admitted by the Old World manufacturers and dealers.) They have invented the most valuable improvements in machinery, much better than anything Europe possesses. Their operatives have become skilled and waste far less than they formerly did, and in many ways, by the concentration of the various processes in large mills instead of spreading them among isolated and independent workmen, as is the custom still abroad, greater economies have been practicable, and at the same time the needs of the market have been more perfectly served than would have been possible under any other system. The competition among American manufacturers has been sufficient to keep down prices of manufactured goods to a very reasonable limit, and still the business done has been enough to enable all to share in the general prosperity. It cannot be said, however, that American silk products are as yet diminishing the importations of foreign goods, for the field is broad enough for all.

The imports of manufactures of silk at the port of New York have been:

In 1876	$21,192,386	In 1878	$20,042,730
In 1877	19,922,741	In 1879	25,830,829

Nearly half as much as the entire imports of last year at this port, however, was produced by the silk mills of Paterson, "the Lyons of America," alone. In 1857 there were in that city only four silk factories, consuming 113,520 pounds of raw silk per annum, running 4,966 spindles, and producing 100,520 pounds of sewing and other silk, none of which was woven here. The present condition of the silk industry here is shown by the following tabulated statement, carefully prepared by Mr. G. Wurts, of the Paterson *Press*:

Number of firms and corporations engaged in silk manufacture in Paterson	77
Number of male operatives	about two-fifths
Number of female operatives	about three-fifths
Number of operatives under 16 years of age	about three-eighths
Total number of operatives	11,465
Amount disbursed fortnightly in wages	$137,305
Amount disbursed per annum	$3,569,930
Capital invested in mill, silk machinery, etc., about	$9,500,000
Number of power looms	2,518
Number of hand looms	1,128
Number of throwing spindles	143,618
Number of braiding spindles	52,838
Square feet of flooring space occupied	1,357,432
Pounds of raw silk manufactured per annum	1,289,200
Value of finished product per annum	$11,987,450
Horse power employed	2,550
Dyeing firms, in addition to private dye houses,	10
Number of men employed	729
Amount disbursed in wages per annum	$397,350
Capital invested, about	$280,500
Square feet of flooring space occupied	73,080
Horse power employed	761
Number of pounds of silk dyed per annum	785,550
Value of product per annum	$4,125,750
Firms dealing in silk manufacturers' supplies	15
Number of hands employed	405
Amount disbursed in wages per annum	$90,710
Capital invested, about	$175,000
Square feet of space occupied	52,735
Horse power employed	112
Value of product per annum	$235,345

The recapitulation of these several interests, numbers, and forces shows:

Total number of firms and corporations engaged in the silk manufacture and its dependencies	102
Total number of hands employed	12,599
Total amount disbursed in wages per annum	$4,066,990
Total amount of capital invested	$9,955,500
Total space occupied in square feet	1,483,267
Total value of product	$12,172,995
Total horse power employed	3,423

Owing to the proximity of Paterson to her great market, the metropolis, the advantage of unlimited water power, and the already established high reputation of her silk goods, she may well look forward to still greater prosperity of this important industry in the future. The silk manufacturers of America have formed a large and influential association, of which Mr. F. W. Cheney is President, and their interests maintain an able trade journal in the *Silk Reporter*, edited by Mr. W. M. Lendrum.—*N. Y. Sun.*

SILKWORM CULTURE IN AMERICA—WHY IT HAS ALWAYS FAILED.

Ever since the days of King James I. of England, misguided persons have been endeavoring to force silk culture in this country. That eccentric monarch made strenuous efforts to compel the planters of Virginia to grow mulberry trees and raise silkworms instead of tobacco, and nobody knows what he might have done in the course of time toward effecting that substitution but for events that gave him a livelier interest in home affairs.

When the stern Puritan Cromwell came into power he did not think it worth while to bother himself about silk culture, if, indeed, he ever thought of it, and thenceforth that industry had to make its way in the New World by virtue of its own attractiveness and promises of profit. It would not be possible to cite any other interest to which so much earnest effort has been devoted in this country, with so uniform a record of failure, yet with so many devoted and hopeful victims, spread over so vast an expanse of territory and through such a long course of years. From the beginning there has been just sufficient success attained to demonstrate that the conditions were favorable in almost every part of the country for the actual growing of the silkworms and their food, but at the same time the existence of an insurmountable obstacle to the profitable prosecution of the business was no less clearly shown.

As early as 1656 silk culture in Virginia was reported as "moderately thriving." Handkerchiefs, dresses, waistcoats, and even a royal robe for Charles I. or Charles II. were, it is said, made in the colonies of native-grown silk. In 1732 the industry was started in Georgia, and twenty-seven years later 10,000 pounds of raw silk were shipped from Savannah to England, where it commanded a better price than any other. South Carolina commenced it about the same time, and in 1755 it was begun in Connecticut—the first mulberry plantation having been started on Long Island. In 1767 the delusion that silk growing was a good thing to do penetrated Pennsylvania, and a few years later to New Jersey, New York, and even to the New England States as far north as Maine. Everywhere the result was the same; the interesting experiment proved to be a financial failure. Yet people kept on struggling with it. Families here and there produced from five to fifty pounds of silk per annum, sometimes even more, but their product was of poor quality, clumsily reeled, and badly spun, fit only for domestic use.

In 1810 the three counties of Connecticut in which the industry was then most flourishing—New London, Windham, and Tolland—produced sewing and raw silk of the value of $28,503, and fabrics from the refuse silk worth possibly half as much more, and still it was a failure.

Of course it was not in American human nature to recognize that a thing could be done, yet admit that a way could not be found for doing it profitably; so Legislatures strove to encourage the silk culture; Congress patted it on the back; the Secretary of the Treasury published a big book about it; rich men, theorists, and experimenters mounted and rode it as a hobby, and finally the ill-advised endeavors of speculative energy and misplaced ingenuity culminated in the memorable *Morus multicaulis* mania of 1838–39. The frenzy that possessed all sorts of persons for the cultivation of white mulberry trees amounted to almost as great a madness as the once famous tulip mania in Holland. Slips of the young trees, worth $3 per 100 in 1835, were sold at $5 each four years later, and there were not enough in the country to supply the demand. Everybody was going to get rich in sericulture. Suddenly, when the bubble was blown to its utmost capacity of expansion, it burst. Thousands of persons were ruined, and silk growing got such a set-back in popular estimation as it has never yet recovered from.

But still there are obstinate beings scattered here and there over the land who try to carry on the business in defiance of the lesson of others' hard experience. A devoted Frenchman in Kansas has sunk a fortune in it; many thousands of dollars were annually spent for several years past in trying to force it in California, and all over the country there are small experiments in it going on constantly. Only a few days ago a large New England silk manufacturer received a letter from a man out West, saying that he had 3,000 cocoons for sale, and wanted to know how many cents each they were worth. They were worth to that manufacturer only a few cents per pound, and their quantity was not sufficient to be worth writing a letter for.

The one insurmountable obstacle in the way of profitable sericulture in this country, to which reference has been made, and one which it is scarcely to be hoped can ever cease to exist here, is the impossibility of procuring intelligent, skilled labor at prices such as are paid in China, Japan, Turkey, Italy, and France.

The production of the cocoon is a very simple matter; the utilization of it a difficult and expensive one. In 1,000 ounces of cocoons there are only 150 ounces of pure silk, and of that only 80 to 100 are fit for reeling. It is in that process of reeling that the value of the silk is established, for it is an exceedingly delicate, slow, and painstaking art, on which depends the evenness of the thread, which is the great desideratum. The cocoons are thrown into warm water to soften the gum which makes their filaments adhere. If the water is too hot it partly dissolves the silk; if hard, it makes the silk liable to break. Six, eight, or ten filaments, each as thin as a thread of a spider's web, are deftly unwound by the reeler from as many cocoons. The gum they bear causes them to adhere. The same number must be kept together all the time. When one breaks, or the available part of a cocoon is exhausted, another must be joined on so evenly that not even under a microscope is a roughness perceptible. The floss silk on the outside of the cocoon is not available, and a certain quantity next the chrysalis must be rejected because it is not an even thickness with the rest and its color is not good. The cocoons are never of the same size, their filaments varying from 1,300 to 3,000 yards in length, and the reeler must know just where to start and where to stop on each individual cocoon, to turn out raw silk. And when he or she knows how to do all that, and is careful in doing it, and works faithfully, he or she may turn out one and a half or two pounds of raw silk by a week's hard labor, and, in doing so, will earn 15 or 20 cents per diem if working in France or Italy, half as much in Turkey, or one-third as much, or even less, in Japan or China.

Is it any wonder, then, that a filature—the technical name for a filament unwinding establishment—cannot flourish in this country, where laborers capable of such work could not be got for less than $1 per diem? Several attempts have been made to start filatures in different parts of this country, and they have always failed, just for that reason—the impossibility of getting sufficiently cheap labor. And the cocoons, viewed as a crude crop, to be shipped abroad for reeling, do not pay. Twelve pounds of them, on the average, will yield one pound of reeled silk, and that, in the "raw" or "gum" state, is worth only about $5.25, or, if of the very highest quality, $6.50. When the cost of shipment, reeling, reshipment, duties, and various profits come to be subtracted from that, how much will it be thought is left for the cocoon grower? That the results attained have not been satisfactory is sufficiently evidenced by the fact that in 1876 it was computed that of 56,000,000 pounds of silk, the world's product, only 16,000 were furnished by the United States, Brazil, and Mexico together. Not a very encouraging showing for the outcome of over two hundred and fifty years of incessant endeavor to establish sericulture in this country.—*N. Y. Sun.*

A NEW METHOD FOR PRODUCING TRANSPARENCIES DIRECT IN THE CAMERA; ALSO FOR THE REPRODUCTION OF NEGATIVES (REVERSED OR OTHERWISE) WITHOUT THE AID OF A TRANSPARENCY.

I am fully aware that several attempts have been made to produce transparencies at one operation in the camera. A few years since I remember one process in particular in which nitric acid was used to dissolve out the image that had been developed, and by having recourse to a second exposure and development the desired result was obtained. This has not come into general favor, because nitric acid and the fumes given off by it exercise a corrosive action on anything that they come in contact with. By the same means negatives also could be reproduced by contact in the printing-frame for reversed negatives or by the copying camera. In the above process collodio-bromide emulsion with alkaline development was used.

A few years previous to that I remember Mr. E. W. Foxlee brought forward a method, in a paper read before the South London Photographic Society, for a similar purpose. In this case he used the wet collodion process with the nitrate bath, and also, if I remember rightly, two exposures to light were given. At the time I saw some very fair results by it; but, like many other good things that have been brought forward from time to time, it was never put to a practical use, for the simple reason that things will not do themselves. I have always found it a very hard matter to get any wet-plate photographer to take up anything that is new, no matter how good it may be; and they try all they can to pooh-pooh everything they do not understand, and go on in one "jog trot" sort of way all the days of their lives. The gelatine process would never have come into general use if it had not been for the rapidity of exposure.

It is several years since I touched wet collodion and the nitrate bath; nor do I mean to have anything more to do with it. To my mind it is perfect slavery compared to emulsion processes.

Many readers of the *British Journal of Photography*, I have no doubt, remember the enlargements on emulsion plates (24 × 18) of cathedrals, etc., that I executed some years ago; I adopted the emulsion on account of the very fine results it gave without coarseness. The method I used at the time was to make a transparency by contact with the original negative, and enlarge from that to the required size. I have always thought that if a simple method could be found to do away with the use of a transparency and enlarge up direct from the small negative to the required size a much finer result would be obtained; for it is well known than an enlarged transparency from a small negative does not show any coarseness whatever. But when we have to make a transparency, and then the enlarged negative from

that, the enlarged negative is not so fine compared with an enlarged transparency from the small negative, the enlarged negative having contracted defects of its own at its different stages.

I saw about a fortnight since, in the *British Journal of Photography*, a method to the same end given by Mr. Thomas Bolas, in which he uses gelatine plates treated with bichromate of potash and developed with the ferrous oxalate developer. The reversed action of light is obtained. In the process that I am about to describe collodio-emulsion plates are used, and only one exposure, similar to Mr. Bolas's method.

To commence with, I use a collodio-bromo-chloride emulsion plate (*no iodide*). I expose the plate in the camera as if I wished to take an ordinary negative (I must not omit to mention that it is a washed emulsion with no preservative applied to the plate). After exposure I take the plate into the dark-room, and flow over it methylated spirit, s. g. about 0·830 or 0·840, allowing about one minute for it to soak into the film. I then place it in a tray of clean water while I prepare the developer, viz.:

Pyrogallic acid....................	3 grains.
10-grain solution of bromide of potassium,	½ ounce.
60-grain solution of cabonate of ammonium...	½ "

After the plate has been well washed I develop with the above solution, either in a dish or on a pneumatic holder. I prefer myself to develop in a tray for all emulsion plates (whether collodion or gelatine). I develop in the first instance as perfect a negative as possible. The high light of the picture—forming, of course, the most opaque parts of the negative—ought to be seen quite as plainly at the back of the plate as on the film side, showing that perfect reduction has taken place of the silver salts contained in the film. I now wash the plate thoroughly to get rid of the ammonia. After this is done I immerse it in the following solution:

Iodine......................	5 to 10 grains.
Alcohol, methylated, s. g. 0·840....	1 ounce.

Sufficient of this must be made up according to the size of the plate. It will be seen that I recommend a low strength of alcohol, for if strong alcohol be used it is liable to attack the film. Any quantity of this tincture of iodine can be made up and used over and over again, strengthening from time to time as the iodine becomes exhausted.

After the plate is immersed in the solution it is advisable to cover the dish with a glass plate to prevent the evaporation of the iodine, and also to avoid inhaling the vapor. After a short time the negative image will be seen to be gradually taken up by the iodine, and at last disappear from sight altogether. It is better to keep the dish in gentle motion all the time to get even action. Before proceeding further the plate must be well examined to see that not a trace of the image is visible; if it be the iodine must be again applied until the plate has the appearance of an unexposed film. The stronger the iodine the quicker is its action on the image that has been developed.

The plate is now well washed in a dish of water to free it from the iodine, both back and front, and again developed with the same alkaline developer. After a short time the negative image makes its appearance again and is fully developed; but now a very remarkable change comes over the plate—it apparently commences to fog slightly. Out of that fog, however, gradually emerges a positive image or transparency. The development is continued until the plate is perfectly clear in the lights. Care must be taken not to arrest the action of the developer too soon, or a mixed-up positive and negative image will be the result. The plate is now well washed and fixed in the usual way, in either hyposulphite of soda or cyanide of potassium.

It will be seen that the part of the film that has been unexposed to the light has been developed perfectly. I am not sure whether the same result may not be brought about by using, for instance, perchloride of iron, chloride of copper, etc. I have not had time myself to try the latter, but hope to do so and return again to the subject in these pages on some future occasion. I have not seen this method published previously, or anything like it. I am sure it is capable of great improvement, and I hope others will work at it and try to make something of it.

For the reproduction of negatives—say for *cartes* or cabinets, or any other sizes—all that has to be done is to bring the original negative in contact with a collodio-emulsion dry plate and develop it; and developed as above the result is a reversed negative equal to the original. If several are required from the same negative, all that has to be done is to correctly time the exposures and develop them altogether in one dish or tray. The result in each will be the same, and they may all be printed in one frame in either silver or carbon.

For enlarging, the negative is placed in the frame ordinarily used for the transparency and enlarged up direct, a soft negative full of detail being suitable for the process. In this case the emulsion can be used either wet or dry, as described by me some time since. I came by this method in a very peculiar manner. A pupil of mine—a medical gentleman—had, as he thought, over-exposed a negative and tried iodine to try to recover it, but the result was that in the end he found the image neither one thing nor the other, and being quite a novice in photography he showed it to me. I applied myself to the task and have worked it out as given above, and I think if it be further worked the method is capable of great things.

I have also found it very useful in another direction. I was making some transparencies from negatives by contact; the light was very uncertain, and I over-exposed some of them. When I found that was the case I treated them slightly with the iodine and brought them back, and then went on with the developer to gain intensity. I believe that by this means an over-exposed plate can be reclaimed. I do not know how far this may answer for gelatine plates that have been over-exposed.

I have tried to reproduce negatives by the use of gelatine plates instead of collodion, but do not find them at all suitable, although the image behaves in a similar manner. I have not gone into the matter chemically, but hope to do so shortly. I do not for one moment suppose that any one would practice the process for the sake of producing transparencies direct in the camera, although, as I have put it forward, it might be serviceable to avoid part of the trouble by producing a transparency in the camera with the view of enlargement to save the extra work in the use of iodine on the large plate.

I believe certain of the manipulations may be conducted in almost open daylight, but should not like at present to give it out as a fact. If what I have seen prove to be correct—and I have every reason to believe it will—it must, I have no doubt, bear upon other very important points connected with dry plate photography. For instance: to treat an exposed gelatine plate with a solution before development, and then to develop the plate in daylight without fogging. I think before long we shall see something of the kind put into a workable form.

WM. BROOKS.

ON VIRULENT DISEASES, AND ESPECIALLY ON THE DISEASE COMMONLY CALLED CHICKEN CHOLERA.*

By M. PASTEUR.

VIRULENT diseases may be ranked among the greatest of the evils that afflict living beings. To prove this we have merely to name measles, scarlatina, variola, syphilis, glanders, the carbuncular disease, yellow fever, typhus, and the cattle plague. This list is far from being complete; the pathology of the most important diseases may find a place here.

When the ideas of Liebig on the nature of ferments were in vogue, each virus was considered as a substance undergoing an internal change, which could be communicated to living organisms, turning the constituents of these into a virus of the same nature. Liebig was well aware that the first apparition of the ferments, their multiplication and their power of decomposition, present the greatest analogies with the phenomena of life, but, in the introduction to his "Organic Chemistry," he tells us that these analogies may be considered as deceitful illusions.

All the experiments which I have communicated to this academy for the last twenty-three years have demonstrated, either directly or indirectly, the inaccuracy of the opinions of Liebig. A single method has guided me in the study of microscopic organisms. This method has been essentially the cultivation of these minute beings in a pure state; that is, by eliminating the heterogeneous substances, living or dead, which accompany them. By the use of this method, the most difficult questions are often solved in the easiest and most decisive manner. I will here recall one of the first applications which I made of this method (1857–1858).

Ferments, according to Liebig, are the nitrogenous substances of organisms, such as fibrine, albumen, casein, etc., in a state of decomposition, resulting from contact with air. There was no fermentation known in which these nitrogenous substances were not present and active. One character of fermentations, as well as of diseases, was that they were spontaneous in their origin and development. In order to show that the hypothesis of the learned German chemist was, to use his own words, "but a deceitful illusion," I made up artificial mixtures whose only constituents were as follows: Water, the mineral constituents essential to life, fermentable substances, and the germs of the ferments which act on these substances. With these mixtures, fermentation took place with a regularity and a purity, if I may use the word, which are never found in the spontaneous fermentation of nature. As every albuminoid substance had been excluded from these mixtures, the ferment appeared as a living being, which borrowed from the fermentable substance all the carbon of its successive generations, and, from the mineral constituents, the nitrogen, phosphorus, potassium, magnesium—elements, the assimilation of which is an indispensable condition to the formation of all living beings, be they great or small.

After these experiments, not only was the theory of Liebig left without any foundation, but the phenomena of fermentation presented themselves as simple phenomena of nutrition, taking place in exceptional conditions, the most extraordinary of which is the possible absence of any contact with air.

Human as well as veterinary medicine made use of the light which shone from these new results. Many investigators made experiments to discover if every virus or contagion was not an animated being. Dr. Davaine, in 1863, endeavored to show the functions of the *bacteridia* of carbuncular disease, which he had discovered in 1850. In 1838, Dr. Chauveau tried to show that virulence was due to the solid particles previously noticed in every virus. Dr. Klebs, in 1872, attributed traumatic virus to microscopic organisms. In 1872, Dr. Kock obtained, by artificial cultivation, the germs of *bacteridia* which were similar in every respect to those which I had pointed out in *vibrios* (1865–70), and the causes of several other diseases were ascribed to microscopic organisms. To-day those who are most opposed to the theory of germs are wavering. Still the greatest obscurity prevails on the most important points.

In the great majority of virulent diseases, the virus has not as yet been isolated, and still less has it been shown, by artificial cultivation, that it is a living organism, and everything contributes to make us regard these "unknown quantities" of pathology as mysterious morbific causes. The study of the diseases which they cause presents many extraordinary circumstances, among which the most remarkable is their non-recurrence. Human imagination can hardly venture to present a hypothetical explanation having any experimental foundation. Is it not still more surprising to find that vaccine, a virulent but mild disease, is a preventive, not only of vaccine itself, but of a more serious disease—the small pox? These facts were known from the remotest antiquity. Variolization and vaccination have been practiced in India from immemorial times, and when Jenner demonstrated the efficacy of vaccination, the common people of the locality in which he practiced medicine knew that cow-pox was a preservative from variola.

Vaccination appears as an isolated fact, but the non-recurrence of virulent diseases appears to be general. The organism does not go twice through measles, scarlatina, typhus, the plague, variola, syphilis, etc.; at least it may be said that the immunity persists for a certain time.

Although in the presence of such mysteries, it behooves us to be humble, I dare to hope that the academy will find that the facts which I am about to have the honor of presenting before it throw unexpected light on the problems raised by the study of virulent diseases.

There occurs sometimes in poultry yards a fearful disease, commonly called chicken cholera. The victim overtaken by it loses its strength, and stumbles about with drooping wings. Its feathers stand on end, and give it the appearance of a ball; it seems overcome by drowsiness; if we open its eyes it seems to awaken from profound sleep, and soon its eyelids close again. Generally death comes after a dumb agony, without the victim even moving from the position it has occupied during the last stages of the disease. In rare cases, it beats its wings for a few seconds. The internal disorders are of a very serious nature. This disease is caused by a microscopic organism which, according to Tundel's Dictionary, was first suspected by M. Moritz, a veterinary surgeon in Upper Alsatia; which was drawn more accurately, in 1878, by M. Peroncito, a veterinary surgeon in Turin; and which was found again, in 1879, by M. Toussaint, professor at the Veterinary School of Alfort, who demonstrated, by cultivation in neutralized urine, that this organism was the cause of the virulence in the blood.

In the study of microscopic parasites, the first, the most useful, condition to fulfill, is to obtain a liquid in which the infectious organism may be cultivated with ease, and without any admixture of other organisms of different species. Neutralized urine, which I have used with so much success to show that the product obtained by the cultivation of the *bacteridia* of Davaine, is identical with the virus of carbuncular disease (1877, Pasteur and Jaubert), does not fulfill the double end in view. But a liquid marvelously adapted to the life of the germ of chicken cholera is a broth made from chicken's muscles, neutralized with potassa, and made sterile by a temperature superior to 100° C. (110° to 115°). The ease with which the microscopic organism multiplies in this liquid seems prodigious. In a few hours the most limpid broth becomes turbid, and is filled with an infinite multitude of small articulations of extreme tenuity, slightly thinner in the middle, and which at first sight have the appearance of isolated dots. These small articulations have no motion of their own, and they certainly belong to a very different group from that of *vibrios*. I imagine that they will be classified some day with other forms of virus, now unknown, when we cultivate these, as I hope we are on the eve of doing.

The cultivation of this microscopic organism presents some very interesting peculiarities.

In my former researches, one of the liquids, which I used with the greatest success, was a decoction of beer-yeast in water, after filtering it to obtain it perfectly limpid, and after rendering it sterile by a temperature superior to 100° C. The most various microscopic organisms thrive on the food presented by this liquid, particularly after being neutralized. For instance, the *bacteridia* of carbuncular disease multiplies suprisingly in a few hours. It is a strange thing that this liquid is entirely unsuited to the life of the organism of chicken cholera, which dies in it in less than forty-eight hours. Is not this entirely analogous to what happens when a microscopic organism is entirely innocuous toward an animal on which it has been inoculated? It remains inoffensive because it does not develop in the body of the animal, and it does not reach the organs essential to life.

The sterility of the decoction of yeast with respect to the microscopic organism of chicken cholera affords us an excellent criterion for the purity of the cultivation of this organism in chicken broth. If the cultivation be pure upon transferring it to a decoction of yeast, no development takes place, and the yeast solution remains limpid. If, however, other organisms are present, they are developed, and the solution becomes turbid. I will in the next place call your attention to a still more extraordinary peculiarity in the cultivation of the germ of chicken cholera. The inoculation of this organism on guinea pigs is not so surely fatal as in the case of chickens. In guinea pigs, particularly in the older animals, the only thing that can be observed is a local lesion at the point of inoculation, which ends in an abscess of greater or lesser volume. This abscess opens spontaneously and heals, and meanwhile the guinea pig eats his food as usual, and seems to possess all the characteristics of health. These abscesses last sometimes for several weeks before discharging, being surrounded by a membrane full of creamy pus, in which the microscopic organism exists in infinite numbers side by side with the globules of pus. It is the life of the inoculated organisms which causes the abscess, which is as a closed vessel, from which we may obtain the organism without endangering the life of the animal. The microscopic organism remains, mixed with pus, in a great state of purity, without losing its vitality. This may be proved by inoculating on chickens a small portion of the contents of the abscess. From the effect of these inoculations the chickens very soon die, while the guinea pig, which has furnished the virus, is entirely cured after a short time. This is an instance of the localized evolution of a microscopic organism, which causes the formation of pus and of a closed abscess, without, at the same time, causing internal disturbances or the death of the animal on which it exists. It is, however, always able to cause the death of other species on which it may be inoculated, and even the death of the animal on which it exists in a closed abscess, if, through some fortuitous circumstances, it should pass into the blood or into the viscera. Chickens and rabbits, living in company with guinea pigs affected with abscesses of this kind, might, all at once, sicken and die, without any great change being observable in the health of the guinea pigs. This could easily happen if the abscesses of the guinea pigs discharged a small portion of their contents on the food of the chickens and rabbits.

An observer who witnessed these facts, and was ignorant of all the points, might well be astonished to see chickens and rabbits die in great numbers without any apparent cause, and he would be apt to believe in some spontaneous disease. Certainly, he would not suppose that the guinea pigs were the cause of all the trouble, when he saw them all in good health, and particularly if he knew that the guinea pigs themselves often suffer from the same disease. Many of the mysteries in the history of contagions will some day be solved in easier ways than the one I have just mentioned. We may reject theories which are in contradiction with known facts, but we must not reject them solely because some of their applications elude our grasp. The combinations of nature are both simpler and more varied than those of human imagination.

I may easily convince you of the truth of these statements, if I add that, if a few drops from a cultivation of our microscopic organism be placed on bread or meat given to chickens, they are sufficient to propagate the evil to their intestines, in which the little organism propagates with such remarkable rapidity that the excrements of chickens so poisoned cause the death of those on whom they are inoculated. These facts enable us to understand the manner in which this fearful disease develops in poultry yards. Evidently the excrements of the diseased chickens have most to do with the contagion. Nothing would be easier than to prevent the spread of the disease by isolating the chickens for only a few days; by washing the poultry yard with plenty of water, and particularly with water containing a little sulphuric acid, which kills the germ of this disease. The excrements should be carried off to a distance. After a few days, the chickens that are still alive could be brought together again with perfect safety, because this disease is so rapidly fatal that in a short time all the diseased animals would be dead.

If the cultivation of the infectious organism in chicken broth is repeated many times over, by passing from one

* Translated from the *Comptes Rendus de l'Academie des Sciences*, of February 9, 1880, by P. Casamajor.

cultivation to the next by sowing an infinitely small quantity, such as may be gathered on the point of a needle, the virulence of the germ is not weakened by the process. This is analogous to the ease with which it multiplies in the bodies of the *Gallinaceæ*. This virulence is so great that the inoculation of a minute fraction of a drop will cause death in two or three days, and most generally in less than twenty-four hours.

Having established these preliminaries, I now come to the most important portion of this communication.

By operating certain changes in the process of cultivation, the virulence of the infectious germ may be much lessened. This is the vital part of the subject. I beg the Academy's permission to withhold a description of the processes by means of which I determine this diminution of virulence. My object is to insure independence in my studies.

The diminution in virulence is seen in cultivations by a slower development of the infectious organism, but, in reality, the two varieties of virus are identical. In the first or very infectious state, the inoculated germ may kill twenty times in twenty. In the milder state, it may twenty times in twenty give rise to illness, but not to death. These facts have an importance which is easily understood, as they allow us to form an opinion, in this particular disease, of the problem of its recidivation or non-recidivation. If we take forty chickens, and inoculate twenty of them with the very virulent virus, these twenty will die. If we inoculate the other twenty with attenuated virus, these will all be ill, but they will not die. We let the twenty chickens be entirely cured, and then if we inoculate them with the very infectious virus, they will not die. The conclusion from this is evident. The disease is its own preventive. It has the character of virulent diseases which do not recidivate.

Let us not be astonished at the singularity of this result. All things are not here as new as they appear at first. In one important particular, however, there is a novelty which will be pointed out. Before the time of Jenner, who himself practiced this method, as I have already mentioned, there was a practice of inoculating variola to preserve from variola. In our day, sheep are inoculated with murrain to preserve them from murrain, and cattle are inoculated with peripneumonia to preserve from this fearful disease. Chicken cholera shows us an immunity of the same kind. It is an interesting fact, but it does not show any theoretical novelty. There is, however, an important novelty in the preceding observations, a novelty which gives food for reflection on the nature of virus. It consists in this, that we have here a disease whose virulent cause is a microscopic parasite, which may be cultivated outside of the animal economy. The virus of variola, the virus of vaccine, those of glanders, syphilis, the plague, etc., are unknown in their nature.

This new virus is a living organism, and the disease to which it gives rise has one thing in common with virulent diseases, properly so called, a quality heretofore unknown in virulent diseases, caused by microscopic parasites; it is that it does not recidivate.

The existence of this disease is a connecting link between virulent diseases caused by a living virus, and other diseases in the virus of which life has never been recognized.

I would not have it believed that the facts present the constancy and mathematical regularity which I have mentioned. To believe this would be to ignore the great variability in the constitution of animals, taken at haphazard from among domestic animals, and also the variability in the manifestations of life in general. The very virulent virus of chicken cholera does not always kill twenty times in twenty. Sometimes this virus only kills eighteen times in twenty, but generally twenty times in twenty. We may also remark that the virus, when reduced in virulence, does not save life twenty times in twenty. Sometimes this happens only eighteen times in twenty, and even sixteen in twenty. Neither is it an *absolute* preservative by one inoculation. We may more surely prevent recidivation by two than by one inoculation.

If we compare the results above stated with what is known of vaccine and its relations to variola, we may see that the less vigorous organism which does not cause death is analogous to a vaccine, relatively to the one that kills, for it gives rise to a disease which may be called mild, as it does not cause death, and, at the same time, it preserves from the disease in its most deadly shape. What other condition must this organism fulfill to be a true vaccine like that of cow pox? This condition is that it should be a definite variety, and that we should not be obliged to prepare it *de novo*, when we wish to use it. We find here the same difficulty which presented itself to Jenner. After he had demonstrated that inoculated cow pox is a preservative against variola, he thought that it was necessary to start from the cowpox of a cow. Jenner soon discovered, however, that he could get along without cows, and make vaccine pass from one arm to another. We may try to do the same by causing our germ to pass from one cultivation to another. Under these circumstances will the germ become actively virulent or will it remain moderately so? Although this may appear very astonishing, I can say that the last supposition is the correct one. The virulence of the germ, in the small number of cultivations which I have attempted, has not increased, and everything seems to point to the existence of a true vaccine. I may even add that one or two trials favor the idea that the attenuated virus keeps its character of mildness after passing through the bodies of guinea pigs. Will the same thing happen after repeated cultivations and repeated inoculations? Only by experiments can such a question be answered.

At any rate, we now know of a disease caused by a microscopic parasite, which may be obtained in such a condition that it does not recidivate as other diseases caused by similar parasites. Moreover, we have a variety of its virus, which behaves toward it as vaccine toward variola.

The Academy may allow me a digression worthy of attention. From what has been said, we can easily obtain chickens affected with the disease called *chicken cholera*, in which death is not a necessary consequence of the disease. We may then witness as many cases of cure as we may wish. Now, I do not believe that experimental surgery has ever met with more curious phenomena than those which are present when the animal returns to health, after inoculations have been made in the large pectoral muscles. The germ of the disease multiplies in the substance of the muscle as it would in a vessel. At the same time the muscle swells, hardens, and becomes bleached at the surface, and below the surface it becomes filled with globules of pus, but does not suppurate. Its histological elements are easily torn, because the parasitical germ is scattered through them in numerous pockets, and it feeds on a portion of their substance. I will, later on, exhibit colored figures showing the disorders caused by the parasitical germ in case of cure. The parasite is gradually arrested in its development and disappears, while at the same time the portion of muscle which has been attacked unites, hardens, and lodges itself in a cavity whose surface resembles that of a healthy granulating wound. The portion which has suffered from the disease finally forms a sequestrum, and is so well isolated in the cavity that holds it that it may be felt by the finger under the skin, and, by the least incision, it may be seized with forceps and extracted. The small wound left in the skin heals immediately, and the cavity is gradually filled by the renewed elements of the muscle. I will now place some of these demonstrations before the Academy.

I have now to close by an explanation relating to the non-recidivation of the disease which occupies our attention. Let us take a chicken thoroughly vaccinated by one or more previous inoculations of the enfeebled virus. What will happen if we inoculate the same chicken again? The local lesion will be insignificant, while the first inoculations, and, in particular, the very first, had been the cause of such marked change in the muscle that a large sequestrum can be easily felt by the touch. The cause of the difference in the effects of these inoculations is to be found entirely in a greater relative facility of the development of the germ of the disease at the first inoculations, and, in the last inoculation, in the development being either entirely wanting or very feeble and promptly stopped. The consequence of this seems evident, and it is that the muscle, which has been seriously diseased, has become, even after it has been cured, unfit for the cultivation of the germ of the disease, as if this germ, by a preceding cultivation, had suppressed some principle which life does not bring back, and whose absence prevents the development of the microscopic organism. I have no doubt that this explanation, to which we are led by palpable facts in this case, will be found to be generally applicable to all virulent diseases.

It must appear superfluous to point out the principal consequences of the facts which I have had the honor to present before this Academy. There are, however, two of these which may be mentioned. One is, that we may hope to obtain artificial cultivations of every virus, and the other is, the idea of obtaining vaccines of the virulent diseases which afflict humanity, and which are the greatest plague of agriculture in the breeding of domestic animals.

It is a duty and a pleasure for me to add that in these delicate and lengthened researches I have been assisted with great zeal and intelligence by Messrs. Chamberland and Roux.

THE PHYSICAL SIGNS DERIVABLE FROM THE BREATH, LIPS, TEETH, AND MOUTH.*

It is my duty to bring to your notice the various physical signs of disease which are to be obtained from an examination of the throat and windpipe; but inasmuch as it is impossible to properly examine the throat without at the same time examining the mouth and nose, I think I shall be best fulfilling my duty by dealing methodically not only with the throat, but also with the oral and nasal cavities which lie above it.

The physical signs met with in these regions of the body appeal not only to the sight, touch, and hearing, but occasionally to the sense of smell as well; and the first thing which forces itself on our attention is often the odor of the breath.

The *smell of the breath* is a valuable physical sign, and in many diseases is so characteristic as to enable the man of experience to form a diagnosis from it alone with almost absolute certainty. It is impossible to describe the various odors of the breath; experience alone will enable you to distinguish one from the other, and I shall merely content myself with cataloguing some of the most distinctive of them. The smell of drink is the most common of all, and in cases of insensibility is often a valuable indication of the cause. It may give a valuable hint as to the habits of the patient; and I would here remind you that over-indulgence in alcoholic liquors is one of the most common causes of congestion and catarrh both of the pharynx and larynx. You must not run too quickly to the conclusion that because a man's breath smells of drink he is necessarily a drunkard, for a single glass of wine or beer is sufficient to impart an odor to the breath for some time after it has been taken. When directing your attention to the alcoholic smell of the breath in the presence of the patient, I am in the habit of speaking of it as *oinosmia* (from *oinos*, wine, and *osme*, an aroma), since patients naturally resent having attention bluntly called to the fact that they smell of drink.

The presence of carious teeth imparts an odor to the breath which is quite characteristic, and which, according to Mr. Salter, resembles no other odor except that given off by the genus of neuropterous insects called *Chrysopa*. Want of attention to the mouth, and allowing food to lie between the teeth and decompose, or the presence of decomposing matters in the crypts of the tonsils, imparts a foul odor to the breath. A disordered stomach also causes the breath to be fetid.

A peculiarly disgusting and perfectly characteristic odor of the breath is present in those cases of chronic inflammation of the nasal and pharyngeal cavities, which are known from this fact as ozæna, and which are most often due to caries or necrosis of the nasal bones which is generally of syphilitic origin. The smell, however, may be present without any disease of the bones in cases of chronic inflammation of the cavities occurring in scrofulous subjects.

In cases of dilatation of the bronchial tubes accompanied by ulceration and copious purulent discharge, the smell of the breath is peculiar and almost diagnostic of the condition, and in gangrene of the lung the odor of the breath reaches a degree of foulness which once smelt can never be forgotten.

In cases of fever, with high temperature, a dry mouth, and the accumulation of sordes on the teeth and gums, the smell of the breath is peculiar. In pyæmia and in diabetes the breath has a sweet odor, but the odor in each of these diseases is perfectly distinguishable.

With inflamed gums the breath is apt to smell. This is peculiarly the case in patients under the influence of mercury, and the term mercurial odor of the breath is one in common use. In scurvy the breath is apt to be very foul. It is needless to say that certain articles of diet, as garlic and onions, and certain drugs, as turpentine, copaiba, and some of the essential oils, are detectable in the breath.

The *inspection of the lips* is capable of furnishing many facts which are of great service in forming a diagnosis. The *form* of the lips is characteristic in different races; thus the thick lips of the African negroes and the thin lips of most European races are well known. In conditions of general plethora the lips look swollen and big. A few cases have been recorded of great hypertrophy of the lips and neighboring parts, a notable example being given by Mr. Barwell in the eighth volume of the Clinical Society's Transactions.

The *color* of the lips is a matter of great importance. After great loss of blood the lips may appear of a waxy whiteness, and such an appearance should at once lead to questions likely to elucidate this point. A recent confinement attended by hemorrhage is the most common cause of this appearance in women. Anæmia and leucocythæmia, arising from no matter what cause, produce a pallor of the lips, and in investigating cases of anæmia, we invariably look to the mucous surfaces of these parts. It is right to remind you, however, that undoubted evidence of hydræmia may be present without any very obvious alteration of the tint of the lips.

The lips are often unduly red in cases of general plethora and in the early stages of many febrile conditions. A cyanotic tint of the lips may be due to extreme cold, to those malformations of the heart which give rise to the condition known as cyanosis, and to a mal-aeration of the blood arising from no matter what cause, atmospheric, pulmonary, or cardiac. A patch of herpes on the lips (*herpes labialis*) is very commonly seen. It is a common accompaniment of an ordinary cold, and it is well to bear in mind that such an appearance may be indicative of more serious trouble, such as pneumonia. It is sufficiently often an accompaniment of pneumonia to make it incumbent upon us always to investigate this point when we are confronted with a patch of herpes on the lips.

In febrile conditions the lips get dry and cracked, and sordes accumulate upon them. Sordes are collections of dried mucus, evaporated saliva, and food particles, which cannot be removed, owing to the general dryness of the mouth and the paucity of the salivary secretions. This condition of the lips is seen in the most extreme degree in the state known as the typhoid condition, in which also the lips are often brown or almost black.

Round the margins of the lips are occasionally seen cracks, white lines, and little pits, the latter reminding one of the appearance known as the lineæ albicantes which occur on the abdomen after pregnancy. These appearances occurring on the lips are sufficient to raise a suspicion of congenital syphilis. The other indications of syphilis which we may find upon the lips are: (1) a true infecting sore or hard chancre, which is happily rare; and (2) mucous tubercles, which may be present in cases of congenital or acquired syphilis. These mucous tubercles have the same appearance when seen here as when seen elsewhere—flat, slightly elevated patches, with a dirty-whitish surface, surrounded by a congested areola. Epithelioma is among the more rare diseases of the lips, concerning which one should be on one's guard.

The *movement* of the lips is a matter of great diagnostic importance. The muscular power of the lips may be impaired or abolished in several distinct conditions, such as hemiplegia, facial palsy, bulbar or labio glosso-laryngeal paralysis, and general paralysis of the insane.

In hemiplegia the lip palsy is often slight, and in very slight cases which have partially recovered, a trifling drooping of the prolabium of the upper lip on one side, just sufficient to destroy the symmetry of the "Cupid's bow," is all that we can detect. The observation of this slight drooping and want of symmetry should always lead to an investigation into the history of the patient, and to questions likely to elucidate the question of hemiplegia. In marked cases of hemiplegia, and in cases of facial palsy from disease or injury to the trunk of the facial nerve, the paralysis of one half of the lips is easily demonstrated, and on asking the patient to show the teeth it will be observed that the teeth are imperfectly exposed on the paralyzed side, and the angle of the mouth is drawn over to the sound side. Facial palsy may be double, and then this want of symmetry is not observed, but the face is expressionless, and the teeth and gums cannot be exposed.

In bulbar paralysis the condition is usually bilateral, and the patient is quite unable to move the lips. In the later stages of this disease the lips waste, and the under lip droops so as to expose the gums and allow the saliva to run out of the mouth.

In general paralysis of the insane there is a paretic condition of the lips, and when they move they do so in a hesitating, jerky manner which is very characteristic.

In alcoholism the movement of the lips is also often tremulous. In chorea the lips are liable to those uncertain jerky movements which are so characteristic of this condition. In "muscular tic" one side of the mouth may be the seat of spasmodic movement. Lastly, in tetanus and spinal meningitis there occurs that condition which is called the risus sardonicus, which is caused by a spasmodic retraction of the angles of the mouth.

Dribbling of saliva is a symptom which is due to many causes. It may be due to an excessive secretion of saliva, a condition seen in cases of mercurial poisoning and in some other states. It is present in cases where there is deficient movement of the lip and tongue, as in bulbar paralysis, or in cases where movement of the tongue is rendered impossible or painful by the presence of sores and ulcers. In patients also with whom the act of swallowing is impaired or painful, as in cases of paralysis or stricture of the pharynx, or inflammation of the tonsils or throat, dribbling of saliva is apt to occur. In children dribbling is a physiological condition, owing to a want of vigor and purpose in the movements of their lips and tongues, and in idiots this infantile condition would seem to be permanent. Old writers considered the dribbling of saliva to be characteristic of idiots and madmen.

An *inspection of the gums* occasionally affords important evidence of disease. Their *color*, like the color of the lips, may be pale or red or livid, and is an indication of anæmia or plethora or those conditions mentioned in connection with the lips which give rise to a cyanotic tint. The gums are sometimes spongy and congested, and liable to bleed at slight causes. This is often the case in depressed conditions of health, arising from whatever cause. It is present in a marked degree in persons who are under the influence of mercury, and to a less extent in those who are taking iodide of potassium. In leucocythæmia and in Hodgkin's disease the gums are often swollen and pale, and occasionally they are stated to become gangrenous. In purpura hemorrhage from the gums is a common occurrence. In scurvy the gums are very greatly and remarkably affected. They become sore and apt to bleed at the slightest touch, and get swollen, spongy, and livid. The lividity is stated to be most

* From a lecture on the Physical Examination of the Mouth and Throat, delivered to the Junior Class of Clinical Medicine, University College, by G. V. Poore, M.D., F.R.C.P., Professor of Medical Jurisprudence, University College; late Assistant Professor of Clinical Medicine; Assistant Physician, and Physician in charge of the Throat Department of the Hospital, etc.—*London Lancet.*

marked at the free edges. The swelling of the gums is so great as occasionally to obscure the teeth, and in extreme cases they protrude between the lips. They get livid and almost black, and undergo sloughing and ulceration, which causes the breath to be peculiarly offensive. The sloughing may leave the crowns of the teeth exposed, and in such cases the teeth commonly fall out. Dr. Buzzard states that this condition of the gums is by no means invariably present in scurvy, and that all the other symptoms of the disease may be present in a marked degree, while the gums are not noticeably affected. Indeed, the gums in scurvy may occasionally be paler than usual and contracted.

A blue line upon the gum may, in the vast majority of cases, be taken as certain evidence that the patient is suffering to a greater or less extent from lead poisoning. This "blue line" is due to a deposit of lead sulphide in the tissues of the gum. Dr. Hilton Fagge has made sections of the margin of a gum affected with a lead line, and by the aid of the lower powers of the microscope was able to see that the discoloration was not uniform, but was distributed in the form of rounded loops. The pigmentation was seen to be due to minute granules, and these granules were situated sometimes in the interior of the smaller blood vessels, and sometimes outside them in the tissue immediately adjacent. The deposit is in reality black, its blue appearance being due to the fact that it is seen through a thin translucent layer of gum. Care must be taken not to mistake the purple congested edge of the gum of persons who do not clean their teeth for the deep blue line which is caused by lead. The blue line is produced by the action of hydrogen sulphide upon the lead which is presumably circulating in the blood. The hydrogen sulphide is produced by the decomposition of food particles lodging between the teeth, and adhering to the tartar. Persons who are careful to keep the teeth clean, and in whom no decomposition of the food particles takes place, may be suffering from lead poisoning and yet have no lead-line upon the gums. The lead-line once formed, and being due to the deposit of an insoluble salt, may remain for months after the system has been freed from lead. Persons who have been exposed to the action of lead may exhibit no line upon the gums until after the administration of iodide of potassium. This is difficult of explanation, but the fact admits of little doubt. The blue or black discoloration caused by lead is not always limited to the margin of the gums, but may occasionally form black patches on the inside of the lips or cheeks.

Occasionally among the ill-fed and dirtily-kept children of the poor, and especially during the first dentition, the gums become swollen and the edges ulcerate, the ulcerated surface being covered with a dirty-gray secretion. This condition is known as gingivitis accompanied by offensive breath, and some increase in the flow of saliva.

The *teeth* often afford valuable evidence of constitutional conditions. Delayed dentition is apt to occur in children that are debilitated from any cause, but more particularly is this the case in rickets. Finding the dentition delayed, we should always search for other evidence of rickets. The milk teeth should begin to appear at the seventh month, and should be all "cut" by the end of the second year. The teeth appear in the following order: central incisors, lateral incisors, anterior molars, canine and posterior molars; and each of these five groups appears by the seventh, ninth, twelfth, eighteenth, and twenty-fourth month; the number of teeth which a child should have at the end of the months named being four, eight, twelve, sixteen, twenty. It may be some help to the memory to call attention to the fact that when a child is twelve months old there should be twelve teeth in the mouth. These numbers are liable to great deviation even in health. Some healthy children are precocious, while others are backward in the matter of dentition. The teeth may be wholly or in part deficient as the result of congenital defect. Caries or decay of the teeth is so common in this country that very few escape from it. It is more common in women than men, and is predisposed to by pregnancy and by the scrofulous and tuberculous constitutions. It is said to be caused by the generation of acid from the fermentation of food particles lodged between the teeth. There is a condition known as "rocky" enamel, in which the enamel of the teeth is grooved and pitted and honeycombed. This condition is brought about by rickets, or by any depressing illness occurring during dentition. Occasionally the teeth get excessively worn, so that they appear truncated, and the dental arch presents the appearance of a flat level border, the exposed dentine presenting a yellowish appearance. This condition, of which a very good sample was lately attending in my out-patient room, is rare, and is said to be predisposed to by syphilis, and to be favored by the use of gritty food. Mr. Jonathan Hutchinson has pointed out that a peculiar condition of the permanent teeth often exists in patients who are the subjects of inherited syphilis. The incisors and canine teeth are small, peg-like in shape, narrow at the free edge, and either excavated by a crescentic notch at the margin or marked by a crescentic groove. The conical condition is most marked, according to Salter, in the lower, and the crescentic notch is most conspicuous in the upper incisors. When the teeth are lost very early in life, inquiry should always be made as to whether the patient has taken much mercury, and, if so, for what reason.

The *mucous membrane of the mouth* is sometimes swollen and red as part of a general catarrh. It may be swollen in consequence of gastric irritation, brought about by errors in diet. In children who are ill-fed, and especially during dentition, small, circular, painful ulcers called aphthæ very frequently appear upon the gums and the internal surface of the cheeks. They are almost always an indication of gastric disturbance from injudicious feeding. When we get the mucous membrane of the mouth inflamed, and upon the inflamed surface a parasitic fungus (the oidium albicans) growing, we have the well known disease called thrush. The mouth, tongue, and palate and pharynx may be covered with white patches, and we may be in doubt whether these patches are due to curdled milk or diphtheria, but if a small quantity be placed under the microscope with a drop of caustic potash, the well known mycelium and spores of the oidium albicans are easily seen, and serve to clear up all doubts. Whether the fungus is the cause of the inflamed condition or whether the patches form a fitting nidus for the growth of the fungus is an open question. Thrush never occurs in well nursed children, and if a young child is fed upon good milk and nothing else, thrush seldom appears. When, however, mothers give farinaceous matter to very young children, often combined with milk which is slightly sour, this sticky mixture adheres to the inside of the mouth, and if the mouth be not very carefully cleansed out after every meal, the decomposing food particles irritate the mouth, cause it to inflame, and form a soil upon which the oidium grows luxuriantly.

Thrush is liable to occur in adults towards the termination of chronic illnesses, when they are too weak to cleanse their mouths by vigorous movements of the tongue. I have seen patches of thrush also occurring in a patient the subject of labio-glosso-laryngeal paralysis, because the movements of the mouth were too feeble for the purpose of properly cleansing it. The lesson to be learnt from these facts is that in feeble persons the mouth needs to be artificially cleansed after feeding by being sponged out with some antiseptic, such as a solution of borax, or, perhaps, there is nothing better than peppermint water, which to many persons is agreeable and refreshing.

CRUDE PETROLEUM IN CONSUMPTION.

M. M. GRIFFITH, M.D., Bradford, Pa., writes: "A great many 'new remedies' and 'new preparations' are now before the public for consideration and sale. I would call attention to an old one, and cheap one. It is a well known fact that consumption is almost unknown in the oil regions of Pennsylvania—and that it is never developed here. The only reason for it is, that we are daily consuming more or less of it in the water we drink and use in cooking purposes. The water obtained from the best wells and other sources, if left to stand over night in an ordinary vessel, will be covered in the morning with a scum of oil. It is evident that most of us consume more or less of it. Consumptive persons coming here from a distance soon find speedy relief from their lung difficulties, and rapidly gain flesh and strength. The climate of Bradford is the most unfavorable; the days in summer very warm, the nights cold and damp, and the weather very changeable, and also much wet and disagreeable weather—so it cannot be the climate that effects the change. The crude petroleum, no doubt, would long ago would have become a popular remedy in lung difficulties, if it had not been for its very nauseating properties. I have sent a supply of the crude oil of a semi-solid consistency, that accumulates on the sucker-rods and casings of the wells, which is readily prepared into pills by incorporating it with any inert vegetable powder, to a number of physicians and hospitals, with a request to give it a trial in their cases of consumption. Sufficient time has not elapsed to give a full report, but thus far the report has been very satisfactory. About fifty per cent. of cures are reported of acute phthisis. It afforded much relief in all cases, and the report in most cases is that it effected cures in all curable cases. I do not claim that it is a specific, but that it will do more good in chronic lung troubles than anything yet suggested.

"The crude is rich in hydrocarbons, and seems to have a special action toward the lungs, relieving cough, hectic, night sweats, and flesh and strength are rapidly gained. I have had it under trial now during the last twelve months, and I can state that my faith in it grows stronger the oftener I prescribe it. The pills are made of the usual size, three to five grains; three to five pills daily, or when the cough is troublesome, or as the case seems to require; relief is apparent from the first. The curable cases were, to all intents and purposes, as well as usual in less than three months; many much sooner."

Petroleum has been known from a very ancient period. Herodotus refers to wells existing in Persia from time immemorial. It was known by the Seneca Indians of our own country as Seneca oil, etc.

The United States Dispensatory refers to it as a stimulating anti-spasmodic expectorant and diaphoretic. It stands high as a domestic remedy in the oil fields. It is to be hoped that the profession will thoroughly investigate the matter, and give their experience of this cheap and valuable medicine.

DR. TANNER'S FORTY DAYS' FAST.

AT noon, on Monday, June 28, 1880, Dr. Henry S. Tanner, of Minneapolis, Minn., began an attempt to abstain from food and drink for forty days and nights, in a hall in New York City. He claims to have fasted for a period of forty-two days, but as almost everybody discredited him, he made up his mind to prove his assertion by repeating the experiment, subject to the constant surveillance of watchers, those watchers to be medical men. Each watcher was obliged to make oath that he watched diligently, and that the fasting man took no food during his (the watcher's) vigil. The watchers are under the supervision of the New York Neurological Society.

At present the faster is wearing a cool suit of dark clothes, white socks, and slippers. He carries a fan, but uses it very little. Since the beginning of the present fast his keen gray eyes have become slightly dimmed, the top of his head, which is thinly covered with gray hair, has become as white as milk; and he has lost ten and a half pounds in weight. The outlines of his regular, well-cut features stand out more clearly, and his firm lips close more tightly.

During the first two days Dr. Tanner drank eighty ounces of water, in doses ranging from six to eight ounces each. Since then, in lieu of drinking, he simply gargles his mouth about once an hour with a couple of ounces of water, which he then ejects into a spittoon. He spends the time reclining on his cot, or sitting up in a chair, or coming forward to the border of his inclosure and talking intelligently and earnestly with his watchers. He reads the newspapers morning and evening, and is very fond of sitting on a chair and elevating his feet to the top of his little writing table. At bedtime he takes a sponge bath. He is then rubbed down with coarse towels, after which he puts on his night dress and gets between the sheets. Before he dresses in the morning, his clothes are examined to ascertain that there is no food concealed in them. His pulse and temperature are frequently taken, and his weight every day. He has already passed the time when, according to medical opinion, he should exhibit delirium and other evidences of insanity, but as yet no dangerous symptoms have been observed.

DR. TANNER AS HE APPEARED DURING HIS RECENT FAST OF FORTY DAYS.

The above and our engraving are from *Frank Leslie's Illustrated Newspaper*. Dr. Tanner successfully completed his remarkable fast of forty days on Saturday, the 7th of August. In subsequent numbers we hope to present some of the physiological observations made during the progress of this extraordinary effort.

BORACIC ACID IN INFLAMMATIONS OF MUCOUS MEMBRANES.

WE learn from the *Maryland Medical Journal* that, at the meeting of the Baltimore Clinical Society, February 21, Dr. J. Shelton Hill reported a case of gonorrhea, in which he employed an injection of boracic acid (half a drachm to four ounces); he next saw the patient four days after, and found him perfectly well. Since that he had used it in a primary attack, increasing the strength to ten grains to the ounce. The disease, which had lasted six days, was cured in one week. The patient was a letter carrier, and continued his employment during the treatment.

He has also employed the agent by inhalation, in follicular tonsillitis, with surprising results. So also in post-nasal catarrh. Finally, he obtained most satisfactory results in a distressing and painful cystitis, due to long-standing resilient stricture, by injections, morning and night (after draw-

ing the urine), of an eight-grain solution. The patient had required the constant use of anodynes, which he administered himself hypodermically. Any attempt to walk caused severe paroxysmal pains and desire to micturate. Eight days ago he began the injections; the urine was then so tenacious that it adhered to the vessel when inverted; the night before he had been up to pass his urine thirteen times. The next night this was reduced to seven times, and there was far less pain. On the second night after the treatment the number was four, and no opium was used for the first time in six weeks. On the fourth night there were two micturitions. Since the 18th only one injection daily has been employed. On the 19th the patient was able to take a long walk without any bad results. The patient had been two months under treatment. At first only a filiform bougie could be introduced, and the stricture had to be dilated. Various astringents had been used for the cystitis, including zinc, acetate of lead, opium, nitrate of silver, etc., but the patient grew steadily worse until the employment of boracic acid; then the improvement was immediate. The injections were made through a small flexible catheter, about No. 2. Specimens of urine passed at various stages of the treatment were exhibited, in which the change from a dark brown purulent fluid to a clear one without deposit was very striking.

APHASIA.

M. MAGNAN commenced his course of lectures on Nervous and Mental Pathology on January 18th, taking aphasia as the subject of his opening lesson. Setting aside glossoplegia, glosso-ataxia, and other cases in which the instrument of speech is at fault, the lecturer confined his attention to the study of two forms of aphasia depending upon disturbances occurring in the psychomotor region of the brain. Of these the first, verbal amnesia, would appear to result from lesions either of the third frontal convolution or of the cortical part of the insula, and the function of speech is lost because its organic substratum is destroyed. In logoplegia, on the contrary, the memory of words remains clear, but the subject is unable to reproduce them, and here we find that the cortex is intact, and that the disease is localized in the bundles of fibers emanating from it. An interesting variety of aphasia is word blindness. After an attack of right paralysis, a man aged sixty-four, who was shown by the lecturer, remained aphasic, naming wrongly objects presented for his inspection. A sentence being written in large letters on the board, the patient was unable to copy it; and yet when told to write it down, the same words having been pronounced, he acquitted himself extremely well. Another man of the same age, who had also suffered from right hemiplegia, was able to make a written communication of considerable length on the state of his feelings, but was incapable of reading a single line of his own writing. The explanation of such cases was simple enough. "The encephalic center which elaborates expression has remained intact, and the fibers which join it to the peripheral organ continue their function. If reading is impossible, it is because the graphic symbol, through some rupture in the conducting fibers, does not reach its center, and does not there awaken a corresponding idea." It will be seen that M. Magnan is a partisan of what Brown-Sequard calls the *clavier* theory.—*Lancet.*

THE HAY FEVER PHILOSOPHERS.

THE next annual meeting of the United States Hay Fever Association, of which Mr. Mark Richards Mucklé, of Philadelphia, is president, is to be held at Bethlehem, N. H., August 31, 1880. The Committee on Scientific Facts, consisting of Dr. Morris Wyman, of Cambridge, Mass; Messrs. M. Richards Muckle and E. W. Holmes, of Philadelphia; Dr. Arthur Holbrook, of Milwaukee, Wis.; Dr. O. N. Baldwin, of Montgomery, Ala.; and Prof. W. H. Parker, of Middlebury, Vt.; have prepared the following report for presentation to the society.

THE REPORT.

The history and geography of diseases are among the most interesting medical subjects. Their origin and development, the course they pursue, their variations in severity and duration, sometimes lasting for a short period only, at others continuing for a hundred years, have been of late investigated with much care, and in some cases leading to unexpected results. For instance, the Oriental plague often overran Europe, and in London, in 1664–5, carried off nearly one hundred thousand souls. But from that time London has enjoyed an immunity from plague, a blessing still generally believed to be due to the great fire of the following year and the succeeding improvements in building and ventilation. But history tells us that it ceased over the greater part of Europe within a few years of its last appearance in England, showing that influences were at work far more powerful and wider spread than those belonging to a single city. The argument drawn from this coincidence of the fire and its consequences must, therefore, be abandoned by the sanitarians notwithstanding it has held a foremost rank with them for the past two hundred years. Positive statements as to the cause of disease can be safely made only after a careful study of its history.

The history of the autumnal form of hay fever in this country has a peculiar interest not only to the sufferers, but to the physicians, because of its comparatively recent appearance and its easily traced development. The early form or "June cold" of England has been carefully studied and described in more than thirty different treatises within the past sixty years, from that of Dr. Bostock, in 1819, to Mr. Blackley's, in 1873. A disease similar in many of its symptoms exists in the United States. It comes on annually at the same time of the year as in England, but there is this striking peculiarity: those who have suffered here in June have subsequently been in England or on the Continent during the same month, in these two apparently similar diseases, without any evidence of the disease, showing that differences exist, but at least so far as causes are concerned. Dr. Beard, of New York, in 1876, in his elaborate work on "Hay Fever," described, under the name of "Summer Catarrh," all the forms or groups of annual catarrhal affections in the country then known to him; the autumnal form numbering among its subjects more than two-thirds of all the sufferers. It should be distinctly understood that this report treats of this last form, only that which begins between the 10th and the end of August and ceases about the 1st of October; and for the reason that it is the most common, the most severe, constant, and life-lasting form, and is that for which relief is most commonly sought by change of residence. It is unknown in England and on the Continent, although natives of those countries develop it here.

A MODERN DISEASE.

Autumnal catarrh, there is reason to believe, must have been very rare in New England fifty years ago. From that time it pretty steadily increased until it attracted the attention of isolated persons, who saw in it, however, only a cold of unusual severity at an unusual season for colds. It was not until long after that its annual character was noticed, partly from the few cases, and also, perhaps, because the disease was at first mild, as was scarlet fever at Kingston, Mass., in 1735 - its first appearance in America—and so of several other diseases. In 1854, when the reporter made it a subject of his lectures in Harvard University, it was looked upon as a medical curiosity which few would ever see. Even in 1866, after a paper had been published of a more popular character, intended to draw attention to the disease and its means of relief, it was not thought worth while for the accommodation of the sufferers to keep open the White Mountain hotels longer than suited the convenience of the summer pleasure seekers. From that time it became more generally known; more facts were collected and were published in the first essay on the subject in 1872. There is abundant reason to believe that the number of cases has increased, but it is hard to say how much, for it is difficult to assign the proper value to increased knowledge and the consequently larger proportion reported, and that due to increased population.

It is certainly remarkable that an affection resembling in so many of its symptoms those of common colds, which are sudden in their onset and variable in their characters, should be bound by such regularity in its time of appearance, go through its several stages without fail, and then cease at a period not so fixed as its beginning, but still varying within very narrow limits. Then again there is that mysterious compensative movement between the June and autumnal forms, in which the first diminishes and even ceases, while the second increases to a certain point in nearly the same proportion; or that other series of changes when the sufferer from the disease of autumn gradually develops that of June, until the two are nearly equal and neither so severe as to be more than a discomfort. But with all its changes and oscillations it is not known to entirely disappear, even during the longest life. Of the early form, on the other hand, Dr. Phœbus, in the best treatise on the English disease, says: "In advanced life single groups of symptoms entirely disappear, and even the whole form of the disease becomes indistinct." Indeed, so slight may it become that Dr. Gordon declares that it "is never observed in the later periods of life," a statement which must be accepted with some reserve. But persistent and troublesome as it is, it seldom leaves a permanent impression upon the general health; it is only exceptionally that it seems to prepare the way for a lasting bronchitis or other serious trouble. As a general rule, soon after the first of October the annoying symptoms disappear, and leave the sufferer much in the condition in which they found him. Nor is it incompatible with long life, several of its victims being octogenarians, and one, Samuel Batchelder, of Cambridge, this year at the extreme age of ninety-five years.

SNEEZERS OF ALL CLASSES.

Attempts have been made to classify those who are subjects of the disease under different temperaments or constitutions, but the conception of temperament is vague, and its terms arbitrary and hard to distinguish; indeed there are as many kinds of constitutions as individuals. So far as yet observed nothing positive can be asserted as to any such arrangement. Taking the most general forms of constitution, the strong or robust, the irritable, the indolent, we cannot say that it affects one more than the other. Neither does the habit of body, as indicated by size, weight, or fatness, show any distinct relation to the disease; it attacks those of light and those of dark complexions, the light haired and the dark haired, those of large and those of small stature, the weak and the strong. Nor is there any peculiar mental condition, unless it be that those suffer most in whom the mental faculties are more constantly in action, and in whom consequently the nervous system is more fully developed than the muscular. But these two classes differ in many respects other than mere muscular development. The one enjoys generally to a much greater extent the beneficial influences of open air and varied occupation. The farmers and mechanics of New England do not suffer from want, as a general rule; they are as well housed, clothed, and fed, and are as well to do, so far as health is concerned, as the richer, and, in some respects, more favored classes.

Autumnal catarrh is not only not associated with any particular condition of body, but its subjects are not known to be particularly liable to any other disease, not even to catarrhal affections. The attacks are said to fall most frequently upon the well, but this is simply because the well vastly outnumber the sick. There is a good reason to believe that strong impressions made upon the nervous system of the body generally may more or less disturb its course, or even break it up for the season, or even for successive seasons. Acute diseases, constant mental excitement, an entire change of occupation from that of a literary life to that of a soldier, and subsequent manual labor, have been known to produce a marked effect.

Race, it is highly probable, has a decided influence. Only one instance of hay fever among colored persons has been recorded. This fact and the complete immunity of negroes from the action of certain vegetable poisons, and from the attacks of certain parasites, and also from most epidemics of yellow fever, point toward important differences between them and the white race. Nationality gives no exemption to those who come to this country and reside in catarrhal regions.

HEREDITY AND LOCALITY.

Finally, predisposition becomes more and more apparent, without, however, the affected individuals of the family presenting any characteristics distinguishing them from the exempt; nor do the affected agree as to the plants or substances most likely to produce paroxysms. Each individual case has its own expression. The *geographical distribution* of autumnal catarrh in its relation to countries, to tracts of territory, and to places of less extent, are, like its history, of great interest not only to sufferers, but to the philosophic physician. But we must here also remember that the special form we have in hand must be carefully distinguished from the earlier form, or "June cold," which has different laws of distribution and relief. A neglect of this has led to the disappointment of sufferers who have sought relief by change of residence and to much confusion in other respects. It is not known in England, Scotland, France, Switzerland, Germany, Sweden, or Norway, while the early or English form is found in most or all these countries.

In this country, it may be said, generally to be most prevalent in New England, and exists in a greater or less degree southward as far as 35° N. latitude, and, exceptionally south of this line, quite to the gulf of Mexico—to Galveston, Texas. It extends westward, certainly as far as the Mississippi river, and isolated cases may be traced as far as Denver; but beyond the Rocky Mountains and in the Lake Superior regions it has not been observed. To the eastward it may be found quite to the St. John River, but not in New Brunswick nor Nova Scotia. The northern boundary is along the southern shore of the great lakes and the St. Lawrence—cases in Canada, even on the shore of the lakes, being very rare. This large tract takes in a great variety of country, inland and upon the seaboard, varying in elevation from the level of the sea to several thousand feet above it. Beyond these limits this disease is very rare, or entirely unknown. The knowledge of these relations to catarrh has been of slow growth and required the collection of many facts.

Within the territory now described there are portions, of greater or less extent, entirely exempt. The first person who is known to have been relieved by a change of residence to an elevated region was a lady from Lynn, Mass. She had suffered severely, especially in the asthmatic stage. She accidentally noticed, in 1853, while traveling in the White Mountain region, that her catarrh, which for twelve years commenced August 20, failed to make its appearance. The following year she visited the same region, before the usual time of attack, with the hope of escaping it. She did escape it, and her annual visits for the remaining ten years of her life were attended by the same happy result. In 1851, two years earlier, Daniel Webster went to the White Mountains, for its invigorating influence, when exhausted by his labors at Washington. His attacks were due August 23. August 25, he writes: "As yet I do not sneeze, nor are my eyes affected. It has not stayed away so long before." September 8, again: "I have been able to keep off the catarrh so far." In the afternoon of that day he went to Boston, and the next day the catarrh attacked him. Mr. Webster evidently escaped his enemy in the White Mountains, but missed the discovery that he escaped it by visiting them. Mr. Jacob Horton, of Newburyport, Mass., who died in 1876, at the age of 79, was more fortunate; he discovered that fact in 1860. This was publicly made known at the time and in the manner already referred to, and soon numbers resorted to the same region for relief. Of those who thus sought relief in the mountains, most obtained it, but not all, for all places in this region are not equally safe.

CITIES OF REFUGE.

Long and varied experience with numerous individuals has proved that the Glen, Gorham, Randolph, Jefferson, Whitefield, Bethlehem village, the White Mountain Notch, Twin Mountain House, the high level about Franconia Notch, are all within the limits of safety. Other elevated tracts are safe: Mount Mansfield at Stowe, Vermont, and the Adirondacks are particularly safe; also the Ohio and Pennsylvania plateau, including the high range of southern counties in New York, from the Catskill Mountains to the western border of the State—the plateau in these counties having an elevation of two thousand feet above the sea. The valleys of the rivers and lakes of the same State, at a lower level, are not safe. The Island of Mackinaw and the country north of the great lakes in Canada, and beyond the Mississippi, at St. Paul, Minnesota, have a certain immunity, but not equal to that of the Lake Superior region. Further west are large tracts which may be resorted to. South, the Alleghany Mountains at Oakland, and other elevated points, and Iron Mountain, on the Tennessee and North Carolina line, are unusually free. To the east, the elevated interior of Maine and its extensive lakes afford both pleasure and safety. Mount Desert is not free, but some of the islands about it are thought to give relief. If the sea coast is preferred, the whole coast east of the St. John, thence quite around to Labrador, is open to the subjects of autumnal catarrh. Sufferers who actually pitch their tents in these favored regions, as a general rule, not only escape their enemy, but may find themselves at the end of the month with a vigor that nothing but living under canvas seems to give.

The limits of the exempt regions are often narrow and very sharply defined. A lady quite well at Bethel, in the White Mountain district, seven hundred feet elevation, experienced an attack after a ride to Albany, but six miles distant and only a few feet lower. So a ride from Peterborough, in Madison County, on the New York plateau, to Chittenango Falls, six hundred feet lower and ten miles away, was followed by an attack. Chemung County, also in New York, affords on its highlands, as a general rule, exemption; but Elmira, in the same county, in the Chemung Valley, affords no relief. By overlooking such facts, sufferers often fall into grave errors, to the great disappointment of their hopes.

A VERY UNCERTAIN MATTER.

The safety of the places has been determined by experience. No one can predict of any region what will be its effect upon a subject of autumnal catarrh; the only test is trial. There is nothing in its geological structure; it may be granite or sandstone; nor in its elevation; nor in its proximity to the sea, which indicates its character in this respect. Even the flora fails us, for it has been proved that Roman wormwood, so prolific of attacks when grown in some places, fails when raised in exempt regions.

It is not to be inferred that all cases of catarrh or asthma, especially those belonging to the early form, or even those occurring in autumn, will be relieved as above stated, for other affections exist, not autumnal catarrh, but somewhat resembling it; these are not cured by the same methods. And again, this affection varies in its severity and its complications; some of these may prove intractable. So of the places just named: they may at times present such changes in temperature, moisture, vegetation, or some other unknown condition, as to interfere materially with their beneficial influences. Such instances have been reported. In 1874, persons residing in some catarrhal regions suffered less than usual, though remaining at home; while those at the White Mountains suffered more than had been their wont during former visits. Mr. Fay, vigilant with regard to everything connected with this disease, reports that "7th September, 1879, nearly every hay fever victim at Bethlehem had an attack of the disease. Soon after, a report came from Colebrook that the same occurred the same day. A letter from Mackinaw reports the same thing on the same day." That such should be the case is in analogy with many things in medicine and physiology, in which nothing is absolute and invariable.

MORRILL WYMAN, for the Committee.

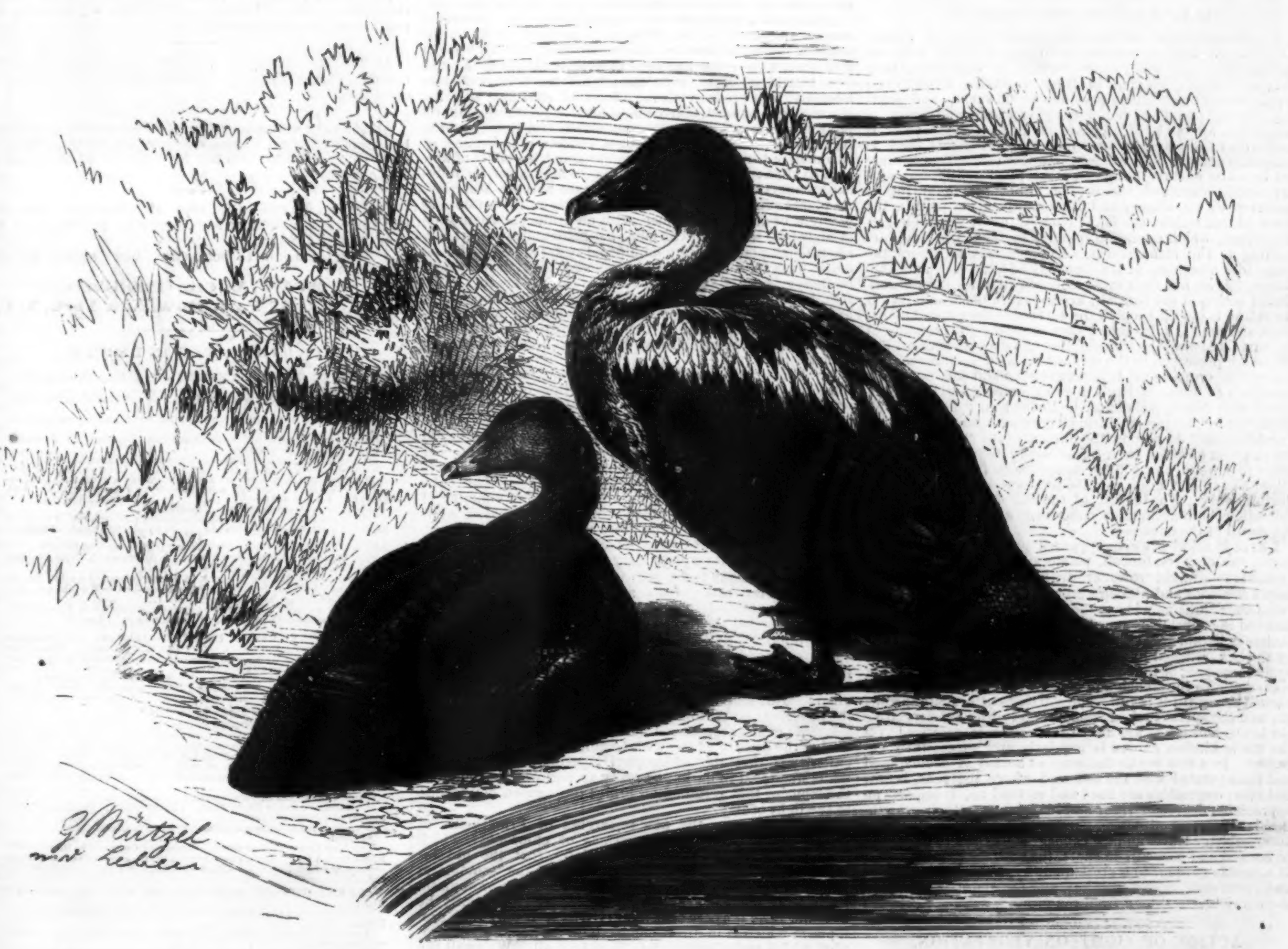
Cambridge, Mass., June 1, 1880.

BLADDERS OF FISHES.

In a recent note to the Paris Academy, Prof. Marangoni gives the results he has arrived at in a study of the swimming bladder. He states, first, that it is the organ which regulates the migration of fishes, those fishes that are without it not migrating from bottoms of little depth, where they find tepid water; while fishes which have a bladder are such as live in deep, cold water, and migrate to deposit their ova in warmer water near the surface. Next, fishes do not rise like the Cartesian diver (in the well known experiment), and they have to counteract the influence of their swimming bladder with their fins. If some small dead and living fishes be put in a vessel three-quarters full of water and the air be compressed or rarefied, one finds in the former case the dead fish descend, while the living ones rise, head in advance, to the surface. Rarefying has the opposite effect. Fishes have reason to fear the passive influences due to hydrostatic pressure; when fished from a great depth their bladder is often found to be ruptured. Thirdly, the swimming bladder produces in fishes a two-fold instability—one of level, the other of position. A fish, having once adapted its bladder to live at a certain depth, may, through the slightest variation of pressure, be either forced downward or upward, and thus they are in unstable equilibrium as to level. As to position, the bladder being in the ventral region, the center of gravity is above the center of pressure, so that fishes are always threatened with inversion; and, indeed, they take the inverted position when dead or dying. This double instability forces fishes to a continual gymnastic movement, and doubtless helps to render them strong and agile. The most agile of terrestrial animals are also those which have least stability.

THE EIDER DUCKS AT THE BERLIN INTERNATIONAL FISHERIES EXHIBITION.

The eider duck (*Somateria mollissima*) is widely celebrated on account of the exquisitely soft and bright down which the parent plucks from its breast and lays over the eggs during the process of incubation. Taking these nests is a regular business on the northern coasts of Norway and Scotland, but is not devoid of risk on account of the precipitous localities in which the eider duck often breeds. The nest is made of fine seaweeds, and, after the mother bird has laid her complement of eggs, she covers them with the soft down, adding to the heap daily until she completely hides the eggs from view. The plan usually adopted is to remove both eggs and down, when the female lays another set of eggs and covers them with fresh down. These are again taken, and then the male is obliged to give his help by taking down from his own breast and supplying the place of that which was stolen. The down of the male bird is pale colored, and as soon as it is seen in the nests the eggs and down are left untouched in order to keep up the breed. The eider is a shy, retiring bird, placing its nest on islands and rocks projecting well into the sea. It is an admirable diver, its legs being set very far back, and obtains much of its food by gathering it under water. The bird lays from five to six eggs, of a pale green color. There are generally two broods in the year.



THE EIDER DUCKS AT THE BERLIN INTERNATIONAL FISHERIES EXHIBITION.

HOW TO BUILD SILOS.

The early way to build silos was to dig trenches in the earth seven feet wide at the top and five feet wide at the bottom, and to fill this with green fodder to the top, and then round it up three feet above the ground, put straw over this, and cover two feet deep with the earth thrown out of the trench, etc. This was a very inferior way to that now adopted of having air tight walls, with plank fitted across the top and weighted down with stone, that may settle with the body of green food, compressing the top surface and excluding the air.

As the writer has had much experience in building concrete walls, which are now regarded as the best for silos because they are easily made air-tight, and has also given instructions for building several silos, it may be of service to give precise instructions for building small sized silos adapted to the amount of stock mentioned, which would be equal to that of eight to ten cows, depending upon the breed of sheep kept.

This would require a silo 12 by 20 feet inside and 12 feet deep, or, better, 14 feet deep, so as to allow for settling of the ensilage. After compression, the ensilage weighs about 50 pounds to the cubic foot, and considering the ensilage to be 12 feet high, after settling, 12 feet wide and 20 feet long, would give 2,880 cubic feet, or 72 tons of 2,000 pounds. This would feed ten good sized cows for six months with a full ration.

BUILDING THE WALLS.

When a single small silo of this size is built, the concrete walls should be 14 inches thick at the bottom and 10 inches thick at the top of the side walls, with the bevel on the outside of the wall, and the end walls 12 inches thick top and bottom, the inside being perpendicular and smooth, so that the plank covering may settle with the ensilage. The concrete wall is stronger than an ordinary stone wall, and for this short silo, 14 inches at bottom is thick enough. It is not best to go any deeper in the earth than can be well drained, and a trench should be cut on the outside of the wall, 6 to 10 inches deep, all around, to carry off all water that may reach this depth. If the land around the silo is nearly level, it is best to go only so deep that the bottom of the wall will be below frost.

Having excavated the earth as deep as the wall is to go, 15 feet wide and 23 feet long, then set the standards for the boxes to form the concrete walls in. It will require 20 standards 3 by 6 inches, 15 feet long (if the walls are to be 14 feet high), of straight grained timber. Those standards intended for the inside of the wall should be jointed straight on one edge, so that the wall may be made very straight and plumb on the inside. There will be three standards upon each long side—one at each corner and one in the middle. The outer edges of these inside standards will be 11 feet 9 inches apart, and as the boxing plank are 1¼ inches thick, this will bring the walls just 12 feet apart. The outside standards will be opposite the inside ones, and just 3 inches farther apart than the wall is thick, so that when the plank are placed inside it forms a box 14 inches wide at the bottom, and the bevel or slant on the outside of the wall is made by bringing the outside standard 4 inches nearer the inside standard at the top. The end standards will be parallel with each other and 15 inches apart. These standards are held together by nailing a lath under the bottom end and a bracket across the top end, holding the side standards 17 inches apart at the bottom and 13 inches at top. Then, when the standards are set up, and the inside standard plumbed very carefully, and both staylathed to hold them firmly in position, and the standards placed all around the proposed silo, it is all ready for fitting in the boxing plank. These boxing planks should be straight grained hemlock or pine, 14 inches wide, 1¼ inches thick, and may be the whole length of each side and end, or, if more convenient, the sides may be two planks long, and the outside end plank will require to be 14½ feet long, but they may run by the ends of the side planks. The outside of the ends must be plumb, so that the outside plank of the long sides can be raised, but the end walls being shorter, 12 inches thick is enough for strength, and has the same material per foot of surface. When these boxing planks are placed, there will be a continuous box, 14 inches on the sides and 12 inches on the ends, around the silo.

PREPARING THE CONCRETE.

Water lime concrete is the only concrete suitable for silos, as it requires a strong, air-tight, smooth wall, and one that can stand moisture to some extent. This kind of wall is easily made air-tight, and is built cheaper than an ordinary stone wall. It is only necessary to use water lime or cement enough to completely coat the particles of sand, so to cement them together, and this becomes a cement to fill in spaces among large gravel or between stones. The cement is made by mixing one part of water lime with four of fine sand, while dry, so that the lime and sand can be evenly mixed. Then work it into mortar, and if you have coarse gravel and no stone you may put in five or six parts of gravel, and this will be sufficient to cement all together. The gravel is best mixed in the mortar bed, but it must be used at once, as such mortar sets in a few minutes after wetting. But if you have rough stones of any kind, cobble or flat stone, they can be worked into the wall to good advantage, and save cement. When stones are to be worked in, put one or two inches of thin mortar in the wall box, then bed into this mortar a layer of stone, keeping the stone back a half inch from the boxing plank, so that the cement may be tamped all around the stone, leaving a smooth surface on both sides of the wall. This cement is a poorer conductor of heat, cold, and moisture, than stone. A properly built concrete wall never shows frost on the inside. In many parts of the country, thin, flat, irregular stones are found in abundance, and these are well adapted to concrete walls, it requiring only a thin layer of concrete mortar between them, and the wall becomes solid in a few days. But with these flat stones, it is better not to bring them quite to the boxing plank, but to let the concrete come over the edges so as to form a smooth surface.

When this concrete wall is laid with stone, sand, and lime, as stated, so large a proportion of stone may be worked in that the water lime will be only one-tenth of the wall, and the same when the wall is made of sand and coarse gravel; so that, to find the amount of water lime required, count one barrel to forty cubic feet of wall to be built. If water lime is very expensive, and you have flat stones, no matter

how irregular, you may use quick lime after you get one foot higher than the earth will come against it. One of quick lime to five of sand will make an excellent mortar to lay these stones in, doing the work in all respects as above stated. The concrete should be well tamped into the boxes, filling all crevices between the stones, and solid against the planks. Water lime will set hard enough so that these boxing planks can be raised twelve inches every day. That is, if you will box all around the silo in one day, the next morning you may raise the boxing planks where you began the day before; and as you fill, raise section after section of planks till you get around again. This you may repeat each day till the wall is completed, provided the mortar sets in the usual time. But if quick lime is used, this sets slower, and will take two or three days to become strong enough to raise the plank. It will be noted that the planks are fourteen inches wide, but are raised only twelve inches, which leaves a lap of two inches on the wall below, keeping the sides of the wall smooth and even. The proposed silo wall will have 952 cubic feet in it, and require twenty-two barrels of water lime, of the Akron or Rosendale brand. This lime in many places will cost from $1 to $1.25 per barrel, or $22 to $27.50. The only other cost of the wall is the labor, which can be done by common laborers. The standards can be set by any one who can use a level and plumb. When the walls are completed, take a seasoned board as wide as the wall is thick, tar one side and turn the tarred side down upon the wall. This will prevent the moisture from rotting the plate rim placed on top of the wall.

The roof placed over this silo must be elevated some three feet above the plates so as to give headroom for filling the silo full. This may be done by framing short posts into the timber on top of the wall, and placing light plates on these upon which the roof is to stand. It will be seen that this silo can be built, by many farmers, with only a small expenditure for water lime, shingles, and nails, all the rest of the materials being from their own farms. The bottom of the silo is usually cemented to prevent moisture from rising from below. I believe the silo is to be generally used in the future for storing green food for winter feeding.—E. W. S., in *Country Gentleman.*

CHEAP MANURE FOR GARDENS.

A correspondent of the Germantown *Telegraph* writes: The effective and economical fertilizing of small fields or gardens, more especially those devoted to vegetables, may obtain by simply digging in fresh vegetable refuse, even weeds pulled or cut green previous to flowering and seeding. So the unsightly and slovenly appearance of heaps in the garden are obviated, that are often seen when there is no covered shed near by for composting. For this there is generally not much leisure left. In this connection it may not be amiss to state that green plants piled tightly, ferment, dry ones decay; and the use of either for manuring is governed by expediency and other motives not within the scope of this article, nor is the composting of vegetable garden refuse, which operation requires more or less time, according to the management. Exposed out of doors the heaps lose nine parts of ten, not only of their size and substance, but also of their most valuable qualities, by the continued action of the sun, air, and moisture thereon. But if the refuse is buried beneath the surface of the ground whilst fresh and green, it is then of easy solution; the moisture of the earth assisting the fermentation and decomposition. The juices are preserved in the soil and nourish the immediately succeeding crops. Yet it is pertinent to add just here, that inasmuch as fermentation is a quick consuming heat compared with decay, which may be likened unto a slow mouldering ember, giving off during its progress gases which feed vegetation and decompose the silicates of soil; therefore turning in green crops or fresh refuse needs frequent renewal in order to supply geine. This escapes more freely in fermentation, as gas and more volatile products are formed than during decay. The texture of the soil also requires consideration, both as regards cohesiveness or friableness and the depth of the covering.

I have in mind a kitchen garden in Europe, where cabbages, cauliflowers, brocoli, potatoes, beans, etc., are planted as usual in straight rows or drills. Before the gardener mows the lawn and pleasure grounds he opens a trench betwixt those hills as wide as the space admits without detriment to the vegetables growing in the rows, and about nine inches in depth. The short grass from the lawn not being, by the bye, relished by the cattle, whenever bone flour or superphosphate of lime is used broadcast for top-dressing, is carried into the trench and closely trodden, or otherwise packed down till it is full. The soil dug out is again thrown on, and the surface raked smooth and even. Every time the lawns and walks are mown this course is practiced, till the whole kitchen garden is regularly and successfully enriched. In a few weeks the grass so buried is decomposed and incorporated with the soil, and where the peas, beans, and other vegetables are hoed and earthed up, it imparts an appreciable degree of vigor and luxuriance to their growth. Besides the grass clippings, potato, pea, and bean vines, the outer cabbage leaves and the cabbage stalks (the latter should be hacked and gashed); in short, the entire vegetable refuse of a sizable garden, to a great quantity, is buried in its fresh and green state in said trenches, and far more than repays the nourishment drawn from the ground.

ACTION OF LIGHT ON VEGETATION.

It is well understood that, for a plant to complete its development and mature its seeds, a certain sum of heat is required, varying according to the species. It appears—as indeed might antecedently be expected—that we should rather say a certain amount of solar radiation; for light, to a certain extent, may replace temperature. This is shown in the effects of almost uninterrupted summer sunshine upon vegetation in high latitudes. According to Schubeler, of Christiania, and others, barley ripens in eighty-nine days from the sowing in Finland, while it requires one hundred days in the south of Sweden, though the latter enjoys a considerably higher temperature. A grain of wheat grown at near the sea level in Norway, or in lower latitudes, when propagated at high elevations or in a high latitude, will mature earlier, even though at a lower temperature; and it is said that, within limits compatible with its cultivation, the grain increases in size and weight. Is this the case with Minnesota and Manitoba spring wheat?

It is inferred, and in various ways seems to be made out, that this is owing to the great amount of light of the prolonged summer days of the higher altitude—a natural explanation, since it is normally or mainly under light that nutritive matter is formed. But we are not told whether the crop of Finland barley raised in eighty-nine days was as large as that produced in one hundred days in southern Sweden under a greater sum of heat but a smaller amount of light. It is said, indeed, that the grain of wheat under such conditions is of greater size and weight, but not that the produce to the acre, or the number of grains to the ear, is increased. From the analogy of Indian corn in this country, the contrary might be expected. This crop in Lower Canada may ripen in fewer days than in Alabama, but only a precocious variety of dwarf stature and scanty product can there be raised at all in the short interval between vernal and autumnal frosts. But maize may be regarded as a tropical plant, inured to northern latitudes only by the development of precocious and dwarf varieties, and, requiring a longer season and a greater sum of heat than barley, it cannot be grown at all in latitudes high enough to enjoy this short but almost continuous sunshine.

That prolonged illumination may thus make up for a certain diminution of temperature is also inferred from the fact that the plants of high northern Europe produce larger and greener leaves than southern individuals of the same species, and the increased brightness of color in blossoms is adverted to in the same sense. Schubeler is said to have shown that biennials and perennials under these conditions lay up a greater store of nutritive matter. Flahault has carried on a series of comparative experiments in this regard, simultaneously conducted at Upsal and Paris. The mean temperature of the summer months differs only slightly, and the rainfall is nearly the same in the two places. But the mean length of the day, between the 15th of May and the 30th of July is 17 hours 49 minutes at Upsal: at Paris, 15 hours and 28 minutes. These experiments are detailed at length in his paper in *Ann. Sci. Nat* (Bot.), 6th Ser., ix., p. 159, etc., March 1880, to be concluded in the April number. The results, so far, favor the above-mentioned conclusion.

Schubeler also makes out that grain, after several generations of cultivation in the highest latitudes or the highest elevation compatible with its cultivation, will, when transferred back to its original locality, ripen earlier than grain which has not been moved. But it loses this precocity in a few generations, and the seeds gradually diminish to the former size and weight. Plants raised from seeds ripened in a high northern locality are hardier than those grown in the south, and are better able to resist excessive winter cold.

Analogous conclusions are reached from the celebrated recent experiments of Dr. Siemens in England, in which the work of the sun is done by the electric light. He confirms in a striking way—what had been otherwise shown in France—that artificial light, even lamplight, when of sufficient intensity, will produce all the effects of sunlight; that the electric light is particularly efficacious in producing chlorophyl and promoting growth; that an electric light equal to that of one thousand four hundred candles at a distance of two meters from growing plants has about the effect of average daylight in England; and that, while under its influence plants can sustain high stove heat without suffering. As plants run their course advantageously in the continuous daylight of an arctic summer, with mere diurnal diminution at nightfall, so that Dr. Siemens has shown that electrically illuminated plants require no diurnal rest, but can be forced on, at least for a considerable time, and their development be thereby greatly expedited. Plants can be grown, therefore, by electric light—by its aid energy can be stored up in food and fuel—which is an interesting rounding of the cycle of transformation; and if the contemplated electro-horticulture fails to be established, it will be because it cannot be made to pay.

An interesting portion of Flahault's paper, above mentioned, is occupied with the investigation of the cases in which chlorophyl is formed in darkness. There are two kinds of cases: 1. The cotyledons of pines, though colorless up to the moment of germination, then turn to bright green even when light has no access to them. Here the green is certainly due to the formation of chlorophyl, and to its production without the intervention of light. This chlorophyl is here formed at the expense of nutritive matter of the albumen of the seed, taken into the cotyledons, *i. e.*, is formed from reserve material. Flahault finds that the young leaves of onion and of crocus, developing from the bulb, fed by reserve material, equally may form some chlorophyl in darkness. Various ferns, growing almost in darkness, have a bright green color, from a well-developed chlorophyl, which must also originate from stored nutritive material; for Borodine has shown that fern-spores will not germinate and develop in darkness, although they contain a certain amount of nutritive matter. 2. The other case is the familiar one of a bright green embryo in the seed from the time of its formation, as in radish, violet, maple, and many others. But here the embryo is not formed in darkness: the coverings or surrounding parts are to a certain and considerable extent translucent, and the chlorophyl is formed during the growth of the well-developed embryo. The peculiarity is, that this chlorophyl remains for a very long while unaltered in darkness, ready to perform its functions the moment that germination brings these green cotyledons to the light of day.

Finally, there are the new researches of Pringsheim, of Berlin, on the nature and functions of chlorophyl, which have attracted much attention. He infers that the physiological use of the green matter is to protect the protoplasm from combustion, or to moderate respiration, the protoplasm itself being the true agent of assimilation. Apparently he does not raise the pertinent inquiry why it is only that protoplasm which is in direct connection or union with chlorophyl which assimilates carbon dioxide at all. We await the future paper, promised by Pringsheim, in which his results and inferences may be further and more clearly developed.—*Amer. Jour. of Science.*

SUCCESSFUL TEA RAISING IN GEORGIA.

A special report from Washington to the *World* states that the officials of the Agricultural Bureau are very much gratified at the progress in tea raising in the South. A Mr. Jackson, who has over thirty-five thousand tea plants on his farm near Savannah, Ga., recently sent to the Commissioner of Agriculture a tin box containing several samples of the tea raised on his farm. The commissioner subsequently took the samples to New York and went incognito to one of the largest tea establishments there, representing that he had some tea to sell. An expert was called in to examine the tea and he pronounced it India tea, worth fifty cents per pound. Commissioner Le Duc then had difficulty in convincing the expert that the tea was grown in this country and could be produced for one-third the price named. The tea is represented as being very palatable and difficult to distinguish from the imported article. Provision having been made by Congress for the establishment of a tea farm, arrangements are now making at the Agricultural Bureau looking to the selection of a place in South Carolina for the experiment. There are constant applications to the bureau for tea-plants, and it is expected that in a short time hundreds of thousands of plants will be growing in this country. The commissioner thinks that it is only a question of a short time when capitalists will begin to see the immense profits to be realized from tea raising, and in a few years he expects that the United States will be producing as much tea and sugar as may be needed for home consumption.

CURRANT WORMS.

A correspondent of the New York *Tribune* has the following to say about these pests and how to avoid them: I wish to make an assertion which may be thought incredible. It is this—*the grower of currants need not be troubled with worms unless he breeds them.* I have some 200 or 300 bushes, this being the third year from setting out, on which the worms have done no damage. I have barely seen some signs of them where my preventive was not sufficiently thorough. My antidote is this: Break off the young growth (as they will sprout from the roots) when six or eight inches high; they will rub off easily if done at the right time. Therefore the affirmation, "no growth, no worms." From one to three main stems is sufficient for a bush. Where no preventive is used the accumulation is enormous. Such a tangled lot of bushes is splendid to breed worms and grow small currants.

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